AVT Marlin

Preliminary
Technical Manual

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ALLIED
Vision Technologies

Before operation

We place the highest demands for quality on our cameras.
This technical manual is the guide to the installation and settingup of the camera for operation.
Please read through this manual carefully before operating the camera.
We also refer to the technical manuals, available on CD or as download for every camera type.

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For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in the Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

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Document History

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0.91	9.1.2004	Typos corrected, minor changes, spectral sens. of IR cut filter added
1.0	20.1.2004	Wording checked, Marlin W90/270 added

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Conventions used in this manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

Styles

Style	Function	Example
`Courier`	Programs, inputs, etc.	"`Input`"
upper case	Register	REGISTER
italics	Modes, fields	*Mode*
parentheses and/or blue	Links	(Link)

Symbols:

ⓘ This symbol highlights important instructions that should be followed to avoid malfunctions.

1 Safety instructions

ⓘ There are no switches or parts inside the camera that require adjustment. The guarantee becomes void upon opening the camera casing.

ⓘ If the product is disassembled, reworked or repaired by other than a recommended service person, AVT or its suppliers will takeno responsibility for the subsequent performance or quality of the camera.

ⓘ The camera does NOT generate dangerous voltages internally. However, because the IEEE-1394a standard permits cable power distribution at voltages higher than 24 V, various international safety standards apply. Reference documents applicable in the United States include:

- Information Processing and Business Equipment, UL 478
- National Electric Code, ANSI/NFPA 70
- Standard for the Protection of Electronic Computer/Data-Processing Equipment, ANSI/NFPA 75

Reference documents applicable in Europe include materials to secure the European Union CE marking as follows:

- Telecommunications Terminal Equipment (91/263/EEC)
- EMC Directive (89/339/EEC)
- CE Marking Directive (93/68/EEC)
- LOW Voltage Directive (73/23/EEC) as amended by the CE Marking

Reference documents applicable in Japan include:

- Electronic Equipment Technology Criteria by the Ministry of Trading and Industry (Similar to NFPA 70)
- Wired Electric Communication Detailed Law 17 by the Ministry of Posts and Telecom Law for Electric Equipment
- Dentori law issued by the Ministry of Trading and Industry
- Fire law issued by the Ministry of Construction

ⓘ Make sure NOT to touch the shield of the camera cable connected to a computer and the ground terminal of the lines at the same time.

ⓘ Use only DC-power supplies with insulated cases. These are identified by having only TWO power connectors.

1.1 Environmental conditions

Ambient temperature:

when camera in use:	- 5° C ... +45° C
when being stored :	- 10° C ... + 60° C

Relative humidity:	20 % ... 80 % no condensed water
Protection:	IP 30

2 Marlin types and highlights

With Marlin cameras, entry into the world of digital image processing is simpler and more cost-effective than ever before.
With the new MARLIN, Allied Vision Technologies presents a whole series of attractive digital camera entry-level models of the FireWire ™type.
These products offer an unequalled price-performance relationship and make the decision to switch from using analogue to digital technology easier that ever before.

The AVT Marlin family consists of five very compact IEEE 1394 C-mount cameras, which are equipped with highly sensitive high-quality sensors (CCD,CMOS). Each of these cameras is available in black/white and color versions.
A large selection of different sensor sizes (1/2 ", 1/3 ", 2/3 ") and resolutions (VGA, SVGA, XGA, SXGA) ensures the suitability of the cameras for all applications.

The MARLIN family consists of the following models:

MARLIN F-033B/C
1/2 " Sony Progressive Scan CCD imager;(VGA) 656 (h) x 494 (v); up to 74 fps at full resolution.

MARLIN F-046B/C
1/2 " Sony Progressive Scan CCD imager;(SVGA) 780 (h) x 582 (v); up to 53 fps.

MARLIN F-080B/C
1/3 " Sony Progressive Scan CCD imager;(XGA) 1032 (h) x 778 (v); up to 20 fps.

MARLIN F-131B/C
2/3 " Global Shutter CMOS imager;(SXGA) 1280 (h) x 1024 (v); up to 25 fps.

MARLIN F-145B2/C2
1/2 " Sony Progressive Scan CCD;(SXGA) 1392 (h) x 1040 (v); up to 10 fps at full resolution.

Operating in 8-bit mode, the cameras ensure very high quality images under almost all circumstances. The MARLIN is equipped with an asynchronous trigger shutter as well as true partial scan, and integrates numerous useful and intelligent Smart Features for image processing.

3 System components

The following system components are included with each camera::

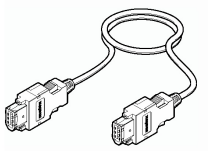
AVT Marlin

4.5m 1394 standard cable

Jenofilt 217 IR cut filter (built in)

Optional:

Tripod Adapter



4.5m latching cable

Driver and documentation

The following illustration shows the spectral sensitivity of the IR cut filter

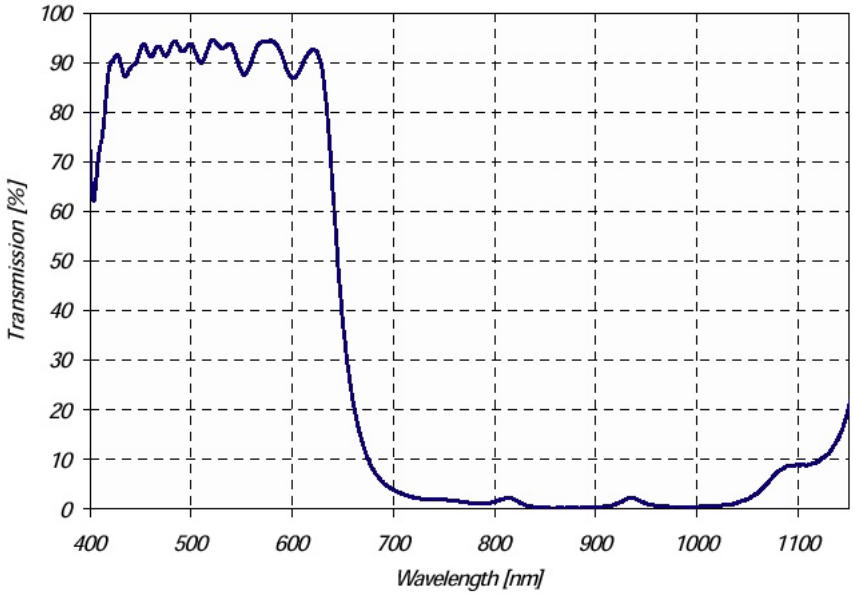


Figure 1: Spectral sensitivity of Jenofilt 217

To demonstrate the properties of the camera, all examples in this manual are based on the "FirePackage" OHCI API software and the "FireView" application.
These utilities can be obtained from Allied Vision Technologies. A free demo version of "FireView" is available for download at www.alliedvisiontec.com.
The camera also works with all IIDC (formerly DCAM) compatible IEEE 1394 programs and image processing libraries.

AVT offers different lenses from a variety of manufacturers. The following table lists selected image formats depending on camera type, distance and the focal width of the lens.

Focal Width MF-033/046	Distance = 0,5m	Distance = 1m
4.8mm	0,5m x 0,67m	1,0m x 1,33m
8mm	0,3m x 0,4m	0,6m x 0,8m
12mm	0,195m x 0,39m	0,39m x 0,78m
16mm	0,145m x 0,19m	0,29m x 0,38m
25mm	9,1cm x 12,1cm	18,2cm x 24,2cm
35mm	6,4cm x 8,51cm	12,8cm x 17,02cm
50mm	4,4cm x 5,85cm	8,8cm x 11,7cm
Focal Width MF-080	**Distance = 0,5m**	**Distance = 1m**
4.8mm	0,375m x 0,5m	0,75m x 1m
8mm	0,22m x 0,29m	0,44m x 0,58m
12mm	0,145m x 0,19m	0,29m x 0,38m
16mm	11cm x 14,7cm	22cm x 29,4cm
25mm	6,9cm x 9,2cm	13,8cm x 18,4cm
35mm	4,8cm x 6,4cm	9,6cm x 12,8cm
50mm	3,3cm x 4,4cm	6,6cm x 8,8cm
Focal Width MF-131	**Distance = 0.5m**	**Distance = 1m**
4.8 mm	0.7 m x 0.93 m	1.4 m x 1.86 m
8 mm	0.4 m x 0.53 m	0.8 m x 1.06 m
12 mm	0.27 m x 0.36 m	0.54 m x 0.72 m
16 mm	0.2 m x 0.27 m	0.4 m x 0.54 m
25 mm	12.5 cm x 16.625 cm	25 cm x 33.25 cm
35 mm	8.8 cm x 11.7c m	17.6 cm x 23.4 cm
50 mm	6 cm x 7.98 cm	12 cm x 15.96 cm

Table 1: Focal Width vs. field of view

4 Specifications

4.1 MF-033B

Specification	
Image device	1/2 " (diag. 8 mm) type progressive scan SONY IT CCD
Effective Picture Elements	656 (H) x 494 (V)
Lens Mount	C-mount
Picture Sizes	640 x 480 pixels (Format_0; Mode_5) 656 x 494 pixels (Format_7; Mode_0)
Cell Size	9.9 µm x 9.9 µm
ADC	10 Bit
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; 30 Hz; 60 Hz; up to 74 Hz in Format_7
Gain Control	Manual: 0–24 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 13 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022,EN61000,EN 55024,FCC Class A, DIN ISO 9022
Options	Removable IR-cut-filter, host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 2: Specification MF-033B

The design and specifications for the products described above may change without notice.

4.2 MF-033C

Specification	
Image device	1/2 " (diag. 8 mm) type progressive scan SONY IT CCD
Effective Picture Elements	656 (H) x 494 (V)@Raw8; 656 (H) x 492 (V)@YUV
Lens Mount	C-mount
Picture Sizes	640 x 480 pixels (Format_0; Mode_5) 656 x 494 pixels (Format_7; Mode_0)
Cell Size	9.9 µm x 9.9 µm
ADC	10 Bit
Color Modes	Raw8, YUV4:2:2, YUV4:1:1
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; 30 Hz; up to 74 Hz in Format_7 (RAW); 68 Hz (YUV 4:1:1); up to 51 Hz in YUV 4:2:2
Gain Control	Manual: 0–16 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 13 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 3: Specification MF-033C

The design and specifications for the products described above may change without notice.

4.3 MF-046B

Specification	
Image device	1/2 " (diag. 8 mm) type progressive scan SONY IT CCD
Effective Picture Elements	780 (H) x 582 (V)
Lens Mount	C-mount
Picture Sizes	640 x 480 pixels (Format_0); 780 x 582 (Format_7)
Cell Size	8.3 µm x 8.3 µm
ADC	10 Bit
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; 30 Hz; up to 53 Hz in Format_7
Gain Control	Manual: 0–24 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: Image transfer by command
Internal FIFO-Memory	Up to 13 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Removable IR-cut-filter, host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 4: Specification MF-046B

The design and specifications for the products described above may change without notice.

4.4 MF-046C

Specification	
Image device	1/2 " (diag. 8 mm) Type progressive scan SONY IT CCD
Effective Picture Elements	780 (H) x 582 (V)@Raw8; 780 (H) x 580 (V)@YUV
Lens Mount	C-mount
Picture Sizes	640 x 480 pixels (Format_0); 780 (H) x 582 pixels (V)@Raw8; 780 (H) x 580 (V)@YUV
Cell Size	8.3 µm x 8.3 µm
ADC	10 Bit
Color Modes	Raw8, YUV4:2:2, YUV4:1:1
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; 30 Hz; up to 53 Hz in Format_7 (Raw8) (36 Hz YUV4:2:2; 49Hz YUV4:1:1)
Gain Control	Manual: 0–16 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 13 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 5: Specification MF-046C

The design and specifications for the products described above may change without notice.

4.5 MF-080B

Specification	
Image device	1/3 " (diag. 6 mm) type progressive scan SONY IT CCD
Effective Picture Elements	1032 (H) x 778 (V)
Lens Mount	C-mount, CS-mount
Picture Sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats; up to 1032 x 778 pixels (Format_7)
Cell Size	4.65 µm x 4.65 µm
ADC	10 Bit
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; up to 20 Hz in Format_7
Gain Control	Manual: 0–24 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 7 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000,EN 55024,FCC Class A, DIN ISO 9022
Options	Removable IR-cut-filter, host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 6: Specification MF-080B

The design and specifications for the products described above may change without notice.

4.6 MF-080C

Specification	
Image device	1/3 " (diag. 6 mm) type progressive scan SONY IT CCD
Effective Picture Elements	1032 (H) x 778 (V)@Raw8; 1032 (H) x 776 (V)@YUV
Lens Mount	C-mount, CS-mount
Picture Sizes	1024 x 768 pixels (Format_1) supporting all smaller fixed formats; up to 1032 x 778 pixels (Format_7)
Cell Size	4.65 µm x 4.65 µm
ADC	10 Bit
Color Modes	Raw8,YUV4:2:2,YUV4:1:1
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; 15 Hz; up to 20 Hz in Format_7 Raw8 (20 Hz at YUV4:1:1 /20 Hz YUV4:2:2)
Gain Control	Manual: 0–16 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger_Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 7 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 7: Specification MF-080C

The design and specifications for the products described above may change without notice.

4.7 MF-145B2

Specification	
Image device	1/2 " (diag. 8 mm) type progressive scan SONY IT CCD
Effective Picture Elements	1392 (H) x 1040 (V)
Lens Mount	C-mount
Picture Sizes	Up to 1280 x 960 pixels (Format_2), supporting all smaller fixed formats; 1392 x 1040 pixels (Format_7)
Cell Size	4.65 µm x 4.65 µm
ADC	10 Bit
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; up to 10 Hz in Format_7
Gain Control	Manual: 0–24 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 3 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Removable IR-cut-filter, host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA)- and WDM stream driver

Table 8: Specification MF145B2

The design and specifications for the products described above may change without notice.

4.8 MF-145C2

Specification	
Image device	1/2 " (diag. 8 mm) Type progressive scan SONY IT CCD
Effective Picture Elements	1392 (H) x 1040 (V)@Raw8; 1392 (H) x 1038 (V)@YUV
Lens Mount	C-mount
Picture Sizes	Up to 1280 x 960 pixels (Format_2) supporting all smaller fixed formats; 1392 x 1040 (Format_7 Mode_0)
Cell Size	4.65 µm x 4.65 µm
ADC	10 Bit
Color Modes	Raw8, YUV4:2:2, YUV4:1:1
Data Path	8 Bit
Frame rates	3.75 Hz; 7.5 Hz; up to 10 Hz in Format_7
Gain Control	Manual: 0–16 dB (0.035 dB/step); Auto gain
Shutter Speed	20 …67.108.864 µs (~67s); Auto shutter
External Trigger Shutter	Trigger Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 3 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; Image sequencing, two configurable inputs, two configurable outputs
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA) -and WDM stream driver

Table 9: Specification MF-145C2

The design and specifications for the products described above may change without notice.

4.9 F-131B

Specification	
Image device	2/3 " (diag. 11 mm) Type global shutter CMOS sensor
Effective Picture Elements	1280 (H) x 1024 (V)
Lens Mount	C-mount
Picture Sizes	Up to 1280 x 960 pixels (Format_2), supporting all smaller fixed formats; 1280 x 1024 pixels (Format_7)
Cell Size	6.7 µm x 6.7 µm
ADC	10 Bit
Data Path	8 Bit
Frame rates	3.75 Hz; 7,5 Hz; 15 Hz; up to 25 Hz in Format_7; 30 Hz @ SVGA and smaller
Gain Control	Manual: 0–13.5 dB (9 x 1.5 dB); Auto gain
Shutter Speed	20 µs …tbd; Auto shutter
External Trigger Shutter	Trigger Mode_0, Trigger_Mode_1 Advanced feature: image transfer by command
Internal FIFO-Memory	Up to 4 frames
# Look Up Tables	One, user programmable (10 Bit -> 8 Bit); Gamma (0.45)
Smart Functions	Real time shading correction; two configurable inputs, two configurable outputs, high dynamic range mode
Transfer Rate	100 Mb/s, 200 Mb/s, 400 Mb/s
Digital Interface	IEEE 1394 IIDC v. 1.3
Power Requirements	DC 8 V – 36 V via IEEE 1394 cable or 12-pin HIROSE
Power Consumption	Less than 3 Watts (@ 12 V d.c.)
Dimensions	58 mm x 44 mm x 29 mm (L x W x H); without tripod and lens
Mass	<120 g (without lens)
Operating Temperature	+5 – +45 ° Celsius
Storage Temperature	-10 – +60 ° Celsius
Regulations	EN 55022, EN 61000, EN 55024, FCC Class A, DIN ISO 9022
Options	Host adapter card, locking IEEE-1394 cable, API (FirePackage), TWAIN (VIA) -and WDM stream driver

Table 10: Specification MF-131B

The design and specifications for the products described above may change without notice.

4.10 Spectral sensitivity

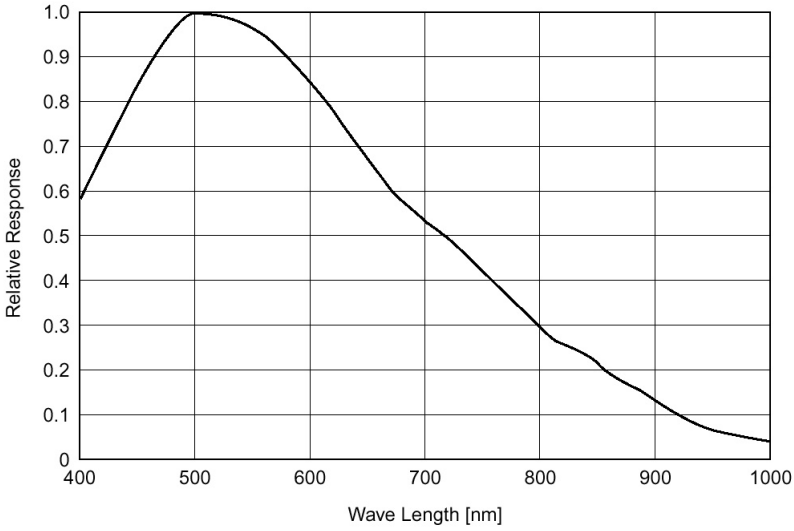


Figure 2: Spectral sensitivity of MF-033B without cut filter and optics.

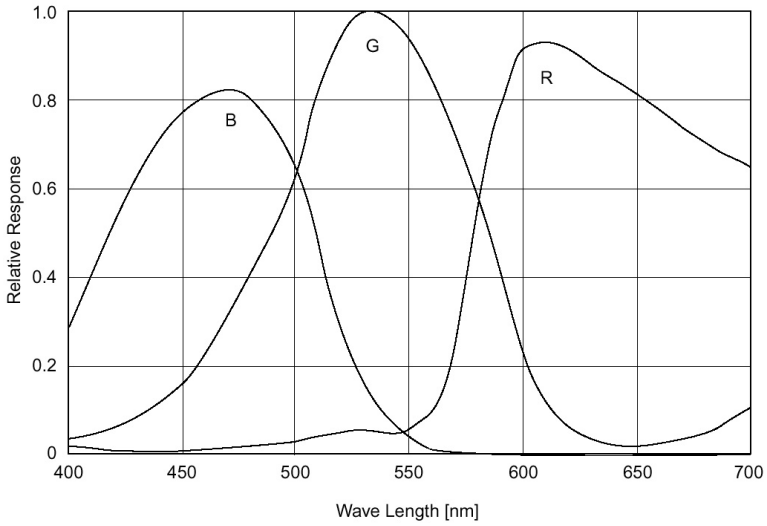


Figure 3: Spectral sensitivity of MF-033C without cut filter and optics

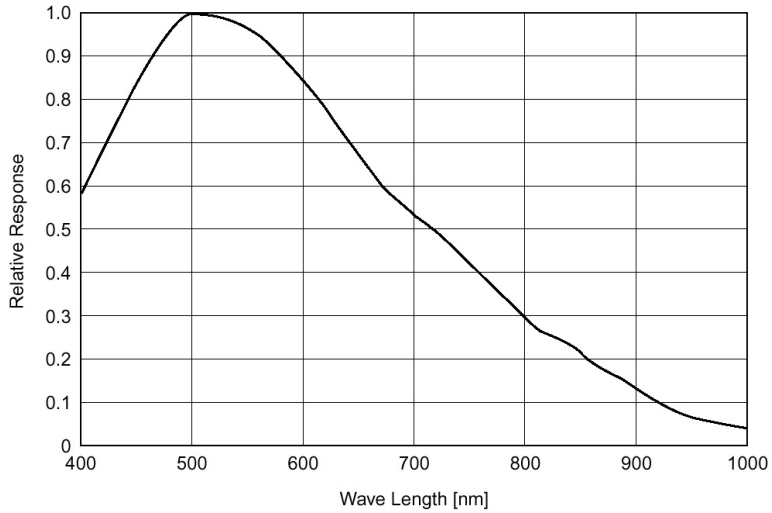


Figure 4: Spectral sensitivity of MF-046B without cut filter and optics.

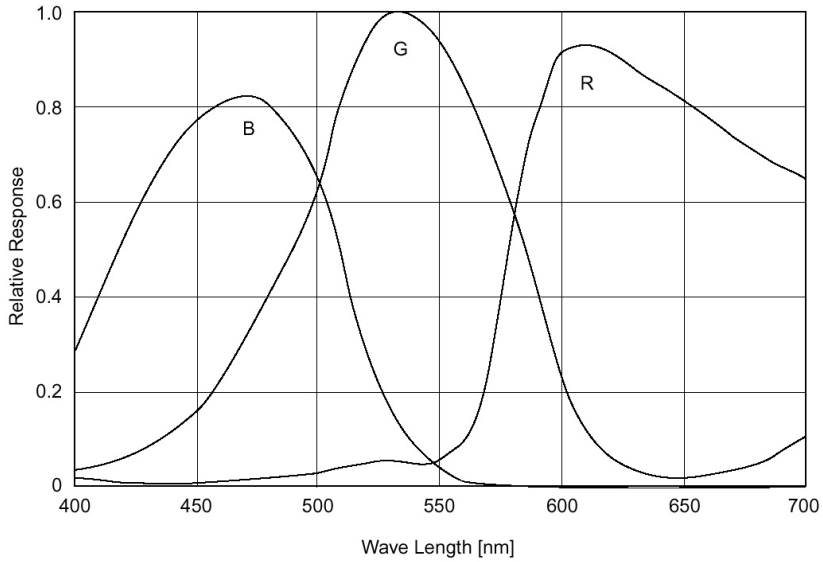


Figure 5: Spectral sensitivity of MF-046C without cut filter and optics.

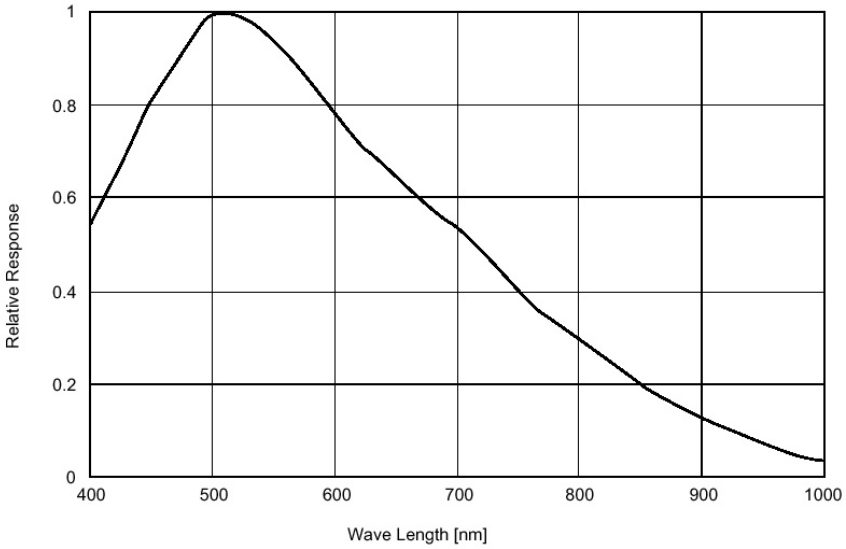


Figure 6: Spectral sensitivity of MF-080B without cut filter and optics

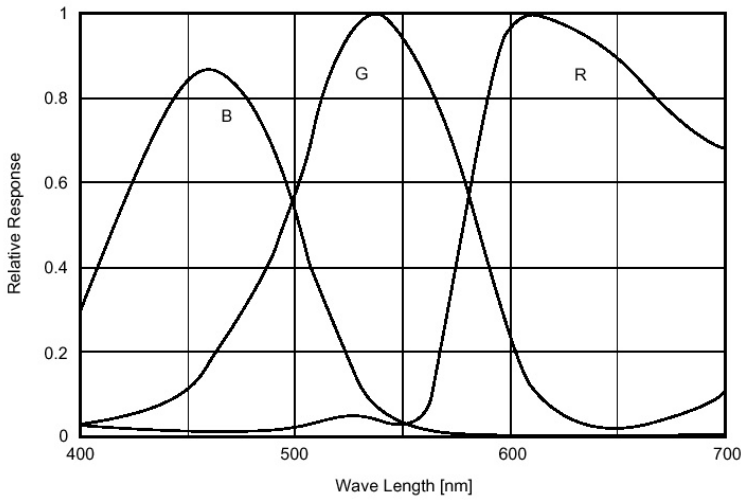


Figure 7: Spectral sensitivity of MF-080C without cut filter and optics.

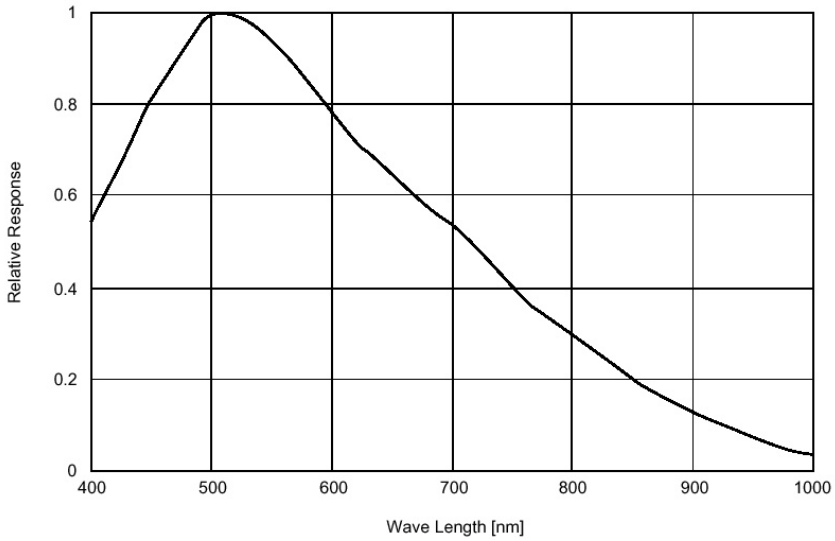


Figure 8: Spectral sensitivity of MF-145B2 without cut filter and optics

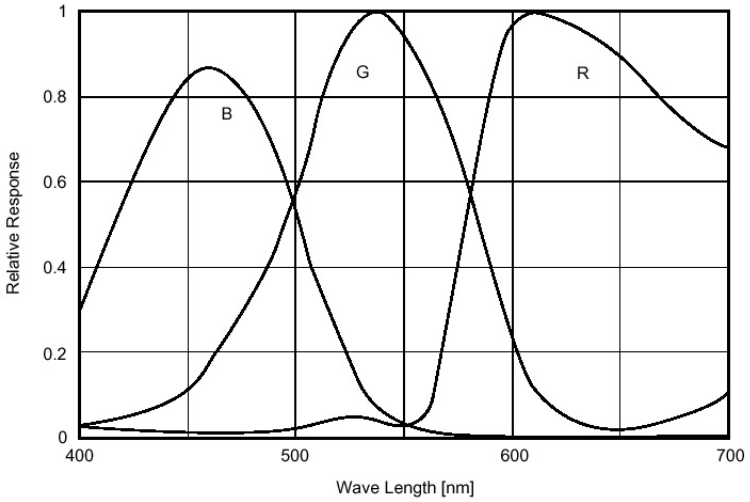


Figure 9: Spectral sensitivity of MF-145C2 without cut filter and optics

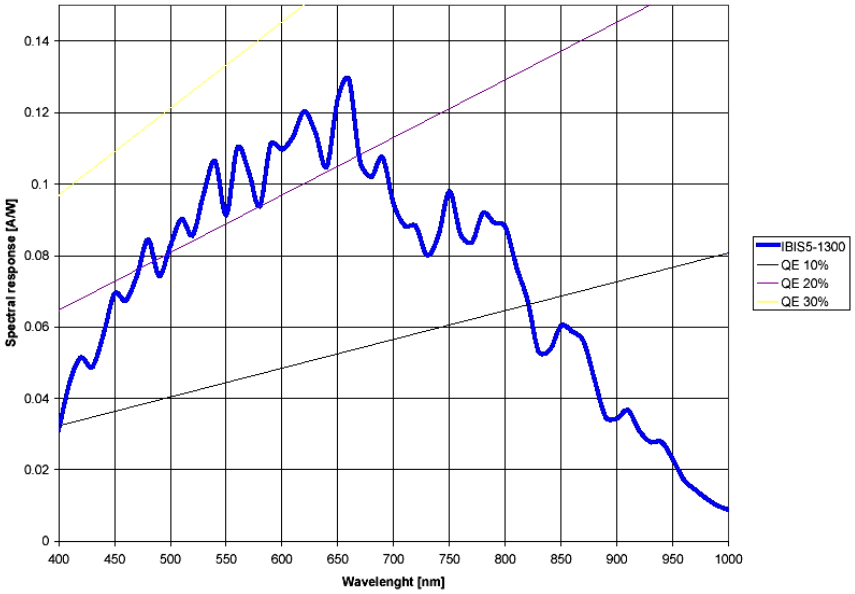


Figure 10: Spectral sensitivity of MF-131B without cut filter and optics

5 Quick start

To connect up an IEEE-1394 camera you need a PC with an IEEE-1394 port and the appropriate software. This IEEE-1394 port is already present in many modern PCs and laptops. Should this not be the case, you can upgrade by installing one or more IEEE-1394 ports in the form of a card for the PCI slot, or as a PC card (PCMCIA) for the PC card slot. AVT offers a range of adaptors for different requirements.

After starting the operating system, the plug and play mechanism on the PC should recognize the new hardware and prompt you to install the IEEE-1394 driver from Microsoft.
AVT supplies from 1Q/2004 additional TWAIN (VIA) drivers and WDM stream software to integrate the images into third party software which has these interfaces.
Alternatively you may use 'the FirePackage API SDK'. This replaces the MS-IEEE-1394 driver with the driver produced by Intek.
A more detailed description for these installation routines can be found in the "FireView" software manual.
The latter driver works in conjunction with the "Viewer" program. This enables quick and easy access to all integrated IEEE-1394 ports and all theconnected IEEE-1394 cameras.
After using the drop down list to choose a matching card, all the available cameras which can be connected to this will be displayed.

Select a camera and connect to this camera by clicking on the *Connect button*. The subsequent dialog offers the option of setting all available video formats and displays the frame in a corresponding window.
In the *Live Control* dialog box you can adjust the settings for the standard registers according to the IIDC specification, e.g. exposure time or gain.
Direct access to the register level, e.g. to activate the advanced features of the camera, is carried out via the *Directcontrol* dialog box.

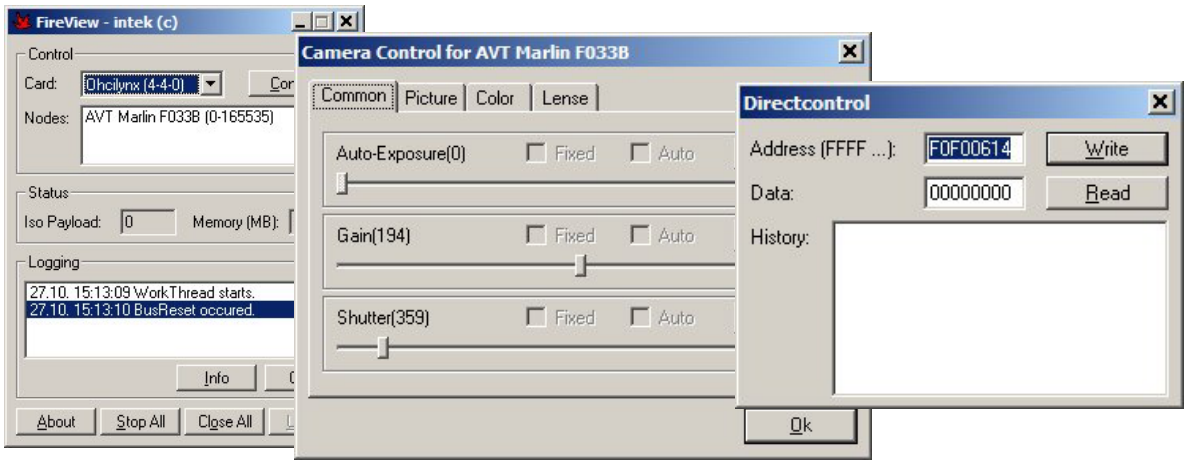
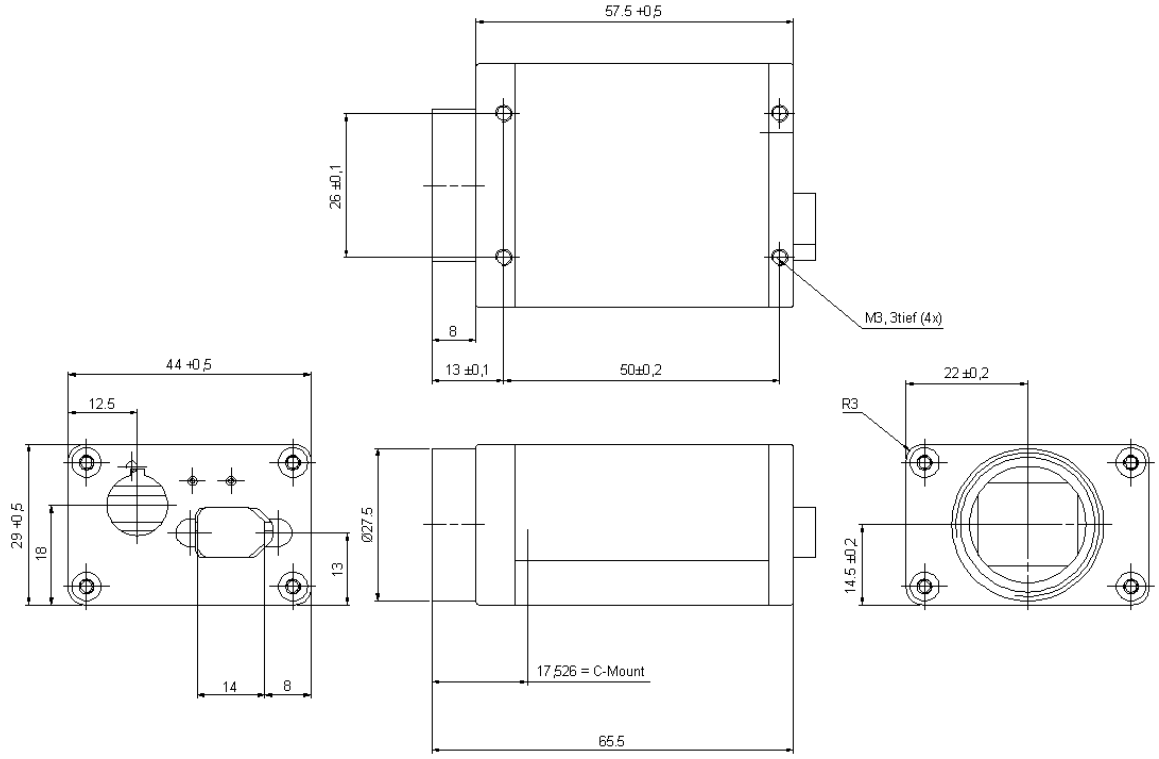


Figure 11: FireView

6 Camera dimensions

6.1 Marlin standard housing



Body size:	58 mm x 44 mm x 29 mm (l x w x h)
Weight:	120 g (without lens)

Figure 12: Camera dimensions

6.2 Marlin W90

This version has the sensor tilted by 90 degrees clockwise, so that it views upwards.

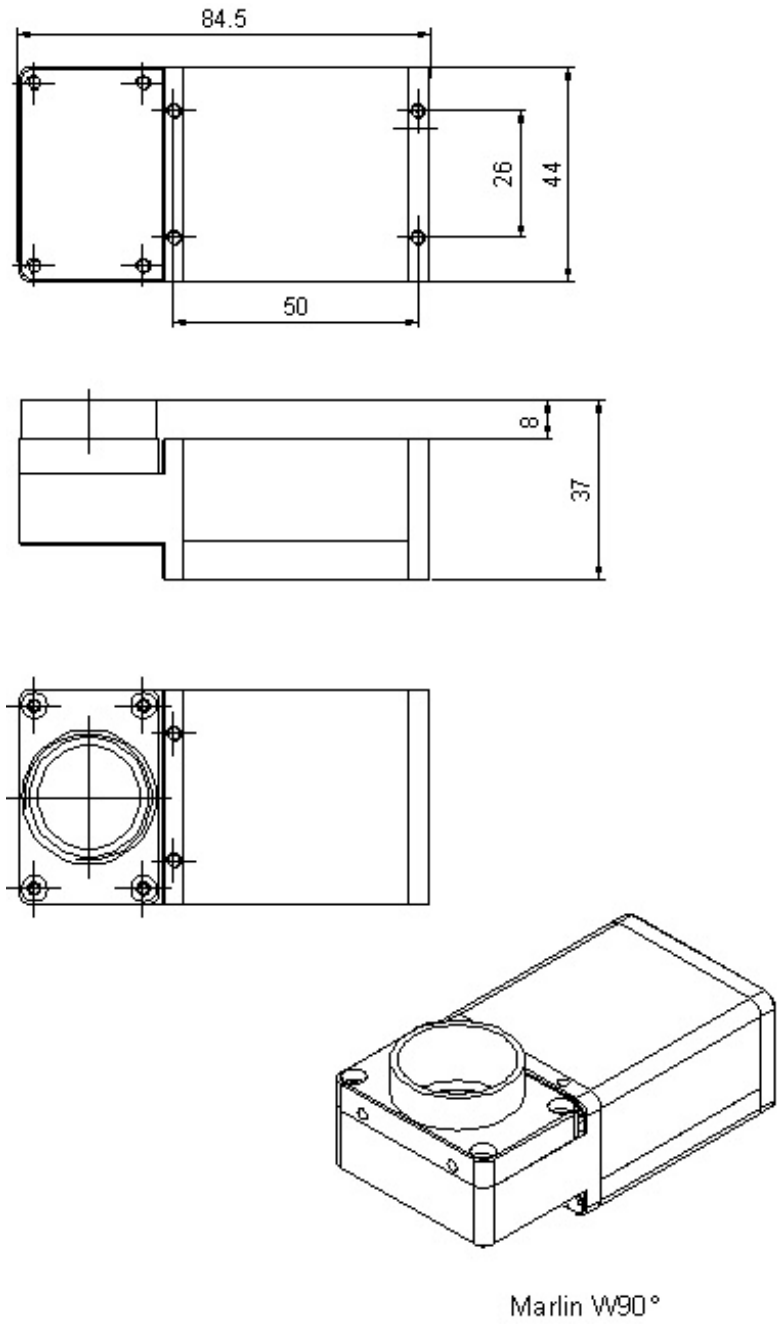


Figure 13: Marlin W90

6.3 Marlin W270

This version has the sensor tilted by 270 degrees clockwise, so that it views downwards.

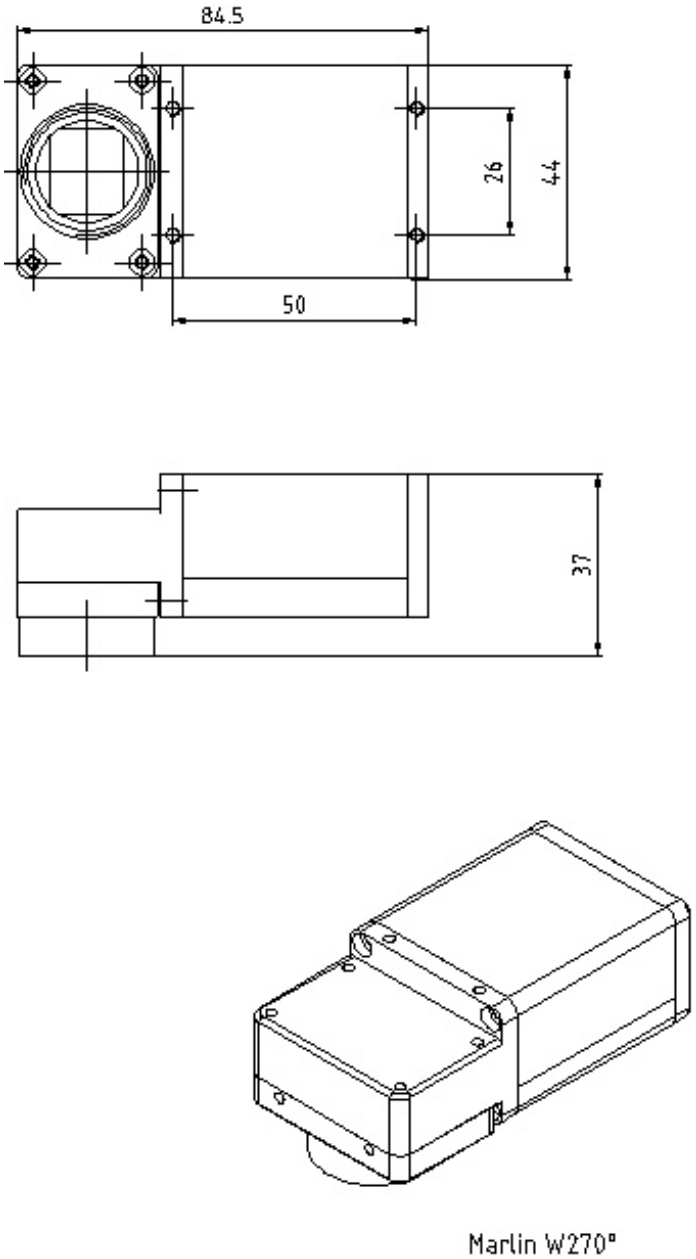


Figure 14: Marlin W270

6.4 Tripod adapter

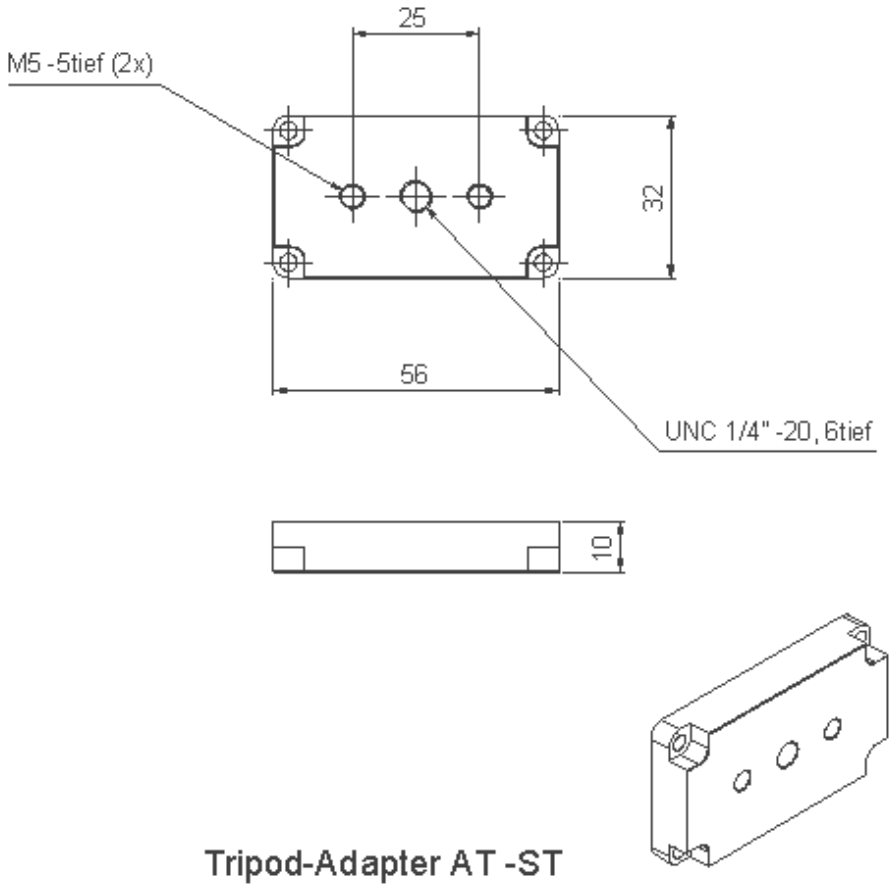


Figure 15: Tripod dimensions

7 Camera interfaces

In addition to the two status LEDs, there are two jacks located at the rear of the camera. The 12-pin HiRose plug provides different control inputs and output lines. The IEEE-1394 connector with lock mechanism provides access to the IEEE-1394 bus and thus makes it possible to control the camera and output frames.

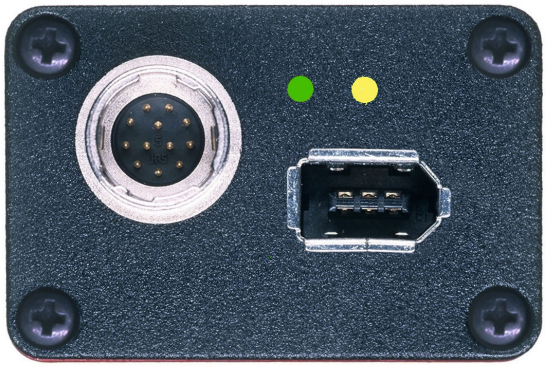


Figure 16: Rear view of camera

7.1 IEEE-1394 port pin assignment

The IEEE-1394 plug is designed for industrial use and has the following pin assignment as per specification:

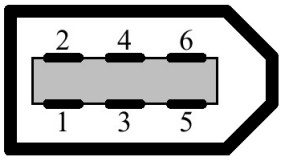


Figure 17: IEEE-1394 connector

Pin	Signal	Pin	Signal
1	Cable power	4	TPB+
2	Cable GND	5	TPA-
3	TPB-	6	TPA+

Table 11: IEEE-1394 pin assignment

7.2 HiRose jack pin assignment

The HiRose plug is also designed for industrial use and in addition to providing access to the inputs and outputs on the camera, it also provides a serial interface for the firmware update. The following diagram shows the pinning as viewed in pin direction.

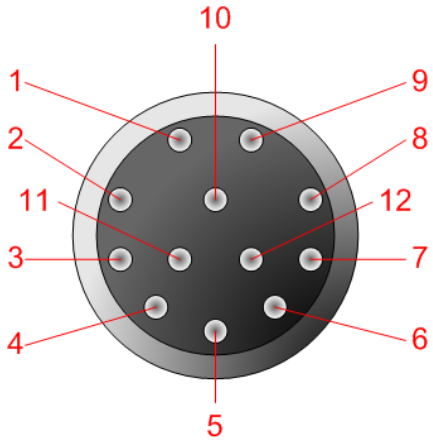


Figure 18: HiRose pin assignment

Pin	Signal	Use	Pin	Signal	Use
1	External GND		7	GPInput GND	
2			8	RS232 RxD	
3			9	RS232 TxD	
4	GPInput 1 (default trigger)	TTL, Edge, progr.	10	OutVCC	
5			11	GPInput 2	TTL
6	GP Output 1 (default IntEna)	Open emitter	12	GPOutput 2	Open emitter

Table 12: HiRose pinning

7.3 Status LEDs

On LED

The green power LED indicates that the camera is being supplied with sufficient voltage and is ready for operation.

Status LED (yellow)

The following states are displayed via the LED:

Com	asynchronous and isochronous data transmission active (indicated asynchronously to transmission over the 1394 bus)
Trg	LED off – waiting for external trigger LED on – receiving external trigger

Table 13: LED indication

Blink codes are used to signal warnings or error states:

Class S1 / Error code S2	Warning 1 blink	DCAM 2 blinks	MISC 3 blinks	FPGA 4 blinks	Stack 5 blinks
FPGA Boot error				1-5 blinks	
Stack setup					1 blink
Stack start					2 blinks
No FLASH object			1 blink		
No DCAM object		1 blink			
Register mapping		2 blinks			
VMode_ERROR_STATUS	1 blink				
FORMAT_7_ERROR_1	2 blinks				
FORMAT_7_ERROR_2	3 blinks				

Table 14: Error Codes

The longer OFF-time of 3.5 sec signals the beginning of a new class period. The error codes follow after a shorter OFF-time of 1.5 sec.

Example: 3.5 sec ➔ one blink ➔ 1.5 sec ➔ 2 blinks

indicates a warning: Format_7_Error_1

7.4 Operating the camera:

Power for the camera is supplied only via the FireWire™ bus.

The input voltage must be within the following range:

Vcc min.: +8 V
Vcc max.: +36 V

ⓘ An input voltage of 12 V is recommended to make most efficient use of the camera.
ⓘ The HiRose connector does not supply power to the camera.

7.5 Control and video data signals

The camera has 2 inputs and 2 outputs. These can be configured by software. The different modes are described below.

7.5.1 Inputs

All inputs have been implemented as shown on the diagram below.

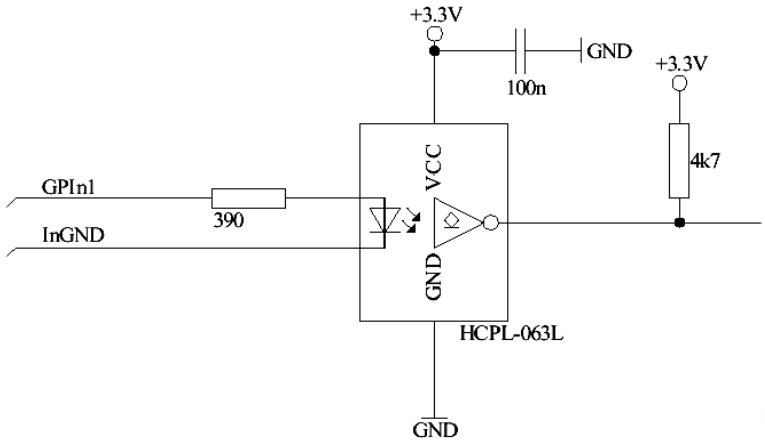


Figure 19: Input schematics

Flux voltage from LED type 1.5 V at 10 mA		Cycle delay of the optical coupler	
min. on-current:	5 mA		
max. off-current:	0.25 mA		
max. input current:	15 mA		
min. pulse width @high speed:	0.67 µs	tpdHL: tpdLH:	745 ns 760 ns
min. pulse width @normal speed:	2.2 µs	tpdHL: tpdLH:	2275 ns 2290 ns

Table 15: Input characteristics

The inputs can be connected directly to +5 V. If a higher voltage is used, an external resistor must be placed in series. Use @+12 V a 470 Ω and @+24 V a 1.2 kΩ resistor.

- ⓘ Voltages above +45 V may damage the optical coupler
- ⓘ Setting inputs to high-speed mode requires very clean input signals. It is recommended to use the normal speed mode (default).

The optical coupler inverts all input signals. Polarity is controlled via the IO_INP_CTRL1..2 register.

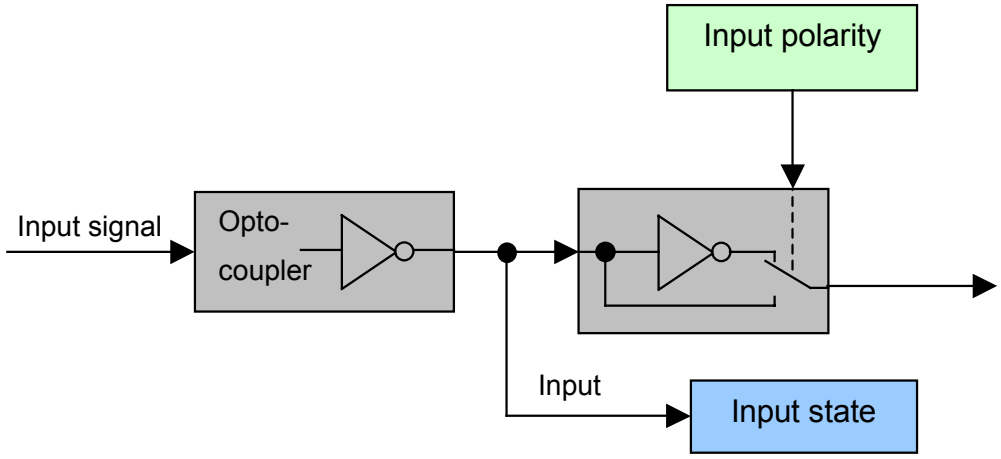


Figure 20: Input block diagram

Triggers

All inputs configured as triggers are linked by AND. If several inputs are being used as triggers, a high signal must be present on all inputs in order to generate a trigger signal. The polarity for each signal can be set separately via the inverting inputs.
The camera must be set to "external triggering" to trigger image capture by the trigger signal.
All input and output signals running over the HiRose plug are controlled by an advanced feature register.

Offset	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	
		Polarity	[7]	0: low active, 1: high active
		---	[8..10]	
		InputMode	[11..15]	Mode
		---	[16..30]	
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		

Table 16: Input configuration register

IO_INP_CTRL 1-2

The *Polarity* flag determines whether the input is low active (0) or high active (1). The *input mode* can be seen in the following table. The *PinState* flag is used to query the current status of the input.

For inputs the *PinState* bit refers to the inverted output side of the optical coupler. This signals that an open input sets the *PinState* bit to “1”.

ID	Mode	Default
0x00	Off	
0x01	reserved	
0x02	Trigger input	Input 1
0x03	reserved	
0x04	reserved	
0x05	tbd (SPI external DCLK)	
0x06..0x0F	reserved	
0x10..0x1F	reserved	

Table 17: Input routing

7.5.2 Outputs

The camera has 2 non-inverting outputs with open emitters. These are shown in the following diagram:

Max. emitter current 500 mA
Max. collector emitter voltage 45 V

ⓘ Voltage above +45 V may damage the optical coupler
ⓘ Depending on the voltage applied at OutVCC, it may be necessary to switch a resistor in series between Gpoutl and ground.

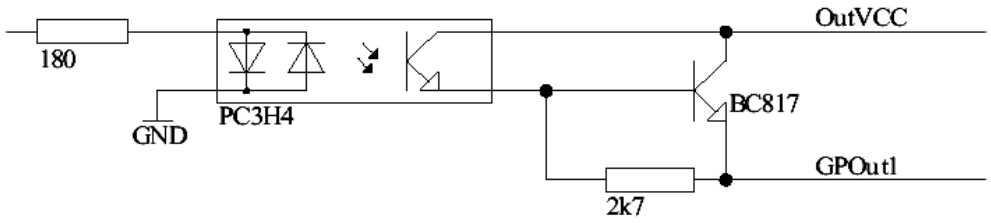


Figure 21: Output schematics

Output features are configured by software. Any signal can be placed on any output.
The main features of output signals are described below:

IntEna Signal
This signal displays the time in which exposure was made. By using a register this output can be delayed by up to 1.05 seconds.
Fval Signal
This feature signals readout from the sensor. This signal Fval follows IntEna.
Busy Signal
This indicator appears when the exposure is being made; the sensor is being read from or data transmission is active. The camera is busy.

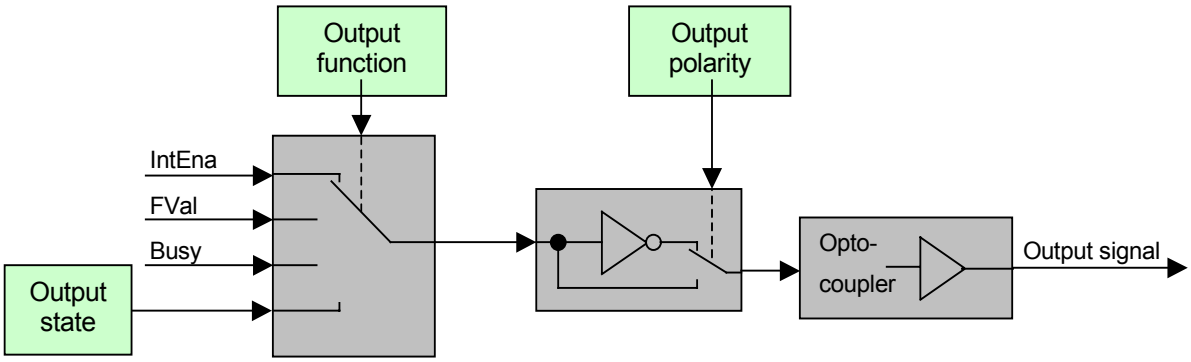


Figure 22: Output block diagram

IO_OUTP_CTRL 1-2

The outputs are controlled via two advanced feature registers.

The *Polarity* flag determines whether the output is low active (0) or high active (1). The *output mode* can be seen in the following table. The current status of the output can be queried and set via the *PinState* flag.

Offset	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	-
		Polarity	[7]	0: low active, 1: high active
		---	[8..10]	
		Output mode	[11..15]	Mode
		---	[16..30]	
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		

Table 18: Output configuration register

Output mode

ID	Mode	Default
0x00	Off	
0x01	Output state follows 'PinState' bit	
0x02	Integration enable	Output 1
0x03	Incremental decoder compare	
0x04	tbd (SPI internal DCLK)	
0x05	tbd (SPI external DCLK)	
0x06	FrameValid	
0x07	Busy	
0x08	Follow corresponding input (Inp1 → Out1, Inp2 → Out2, …)	Output 2
0x09..0x0F	reserved	
0x10..0x1F	reserved	

Table 19: Output routing

The "Polarity" setting refers to the input side of the optical coupler output, "PinState 0" switches off the output transistor and produces a low level over the resistor connected from the output to ground.

The following diagram illustrates the dependencies of the various output signals.

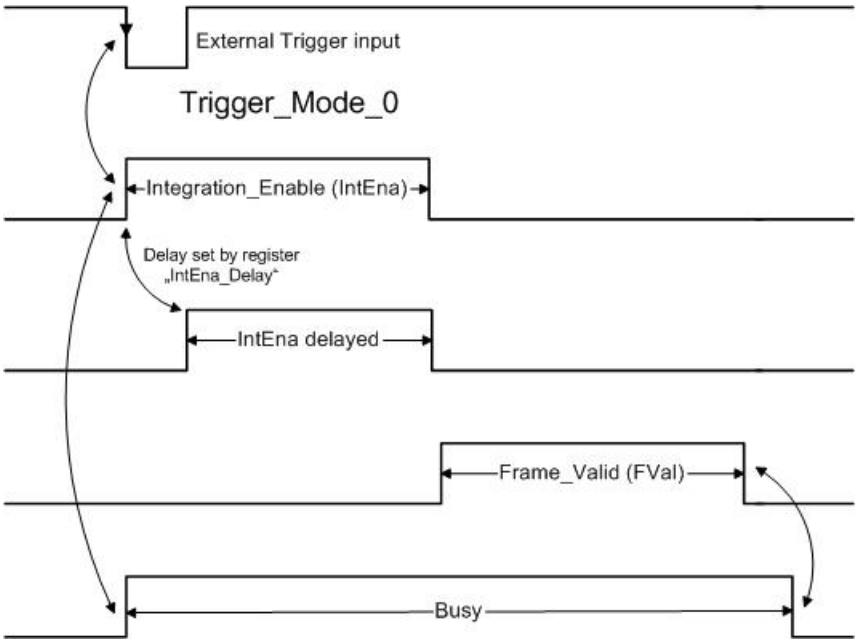
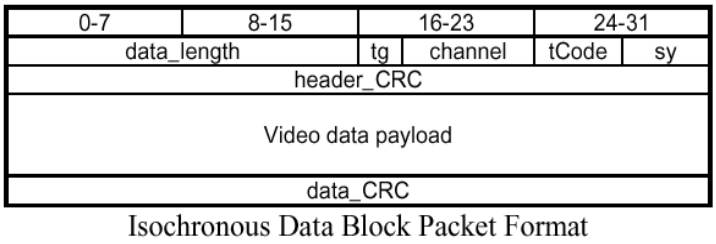


Figure 23: Output Impulse Diagram

ⓘ Please note that polarity of the signals can be changed.
ⓘ Firing a new trigger while IntEna is still active may lead to image corruption because of double exposure.

7.6 Pixel data

Pixel data are transmitted as isochronous data packets in accordance with the 1394 interface described in IIDC v. 1.3. The first packet of a frame is identified by the "1" in the sync bit (sy) of the packet header.



Isochronous Data Block Packet Format

Table 20: Isochronous data block packet format: Source: IIDC v. 1.3 specification

Video data for each pixel are output in an 8-bit format. Each pixel has a range of 256 shades of gray. The digital value 0 is black and 255 is white.

The following table provides a description of the video data format for the different modes. (Source: IIDC v. 1.3 specification)

<YUV (4: 2: 2) format >

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

<YUV (4: 1: 1) format >

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	Y-(K+6)	Y-(K+7)
U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

Table 21: YUV 4:2:2 and YUV 4:1:1 format: Source: IIDC v. 1.3 specification

<Y (Mono) format >

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	Y-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

< Y (Mono16) format >

High byte	Low byte

Y-(K+0)	Y-(K+1)
Y-(K+2)	Y-(K+3)
Y-(K+Pn-4)	Y-(K+Pn-3)
Y-(K+Pn-2)	Y-(K+Pn-1)

Table 22: Y8 and Y16 format: Source: IIDC v. 1.3 specification

<Y, R, G, B>

Each component has 8bit data. The data type is "Unsigned Char".

	Signal level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	:	:
	1	0x01
Lowest	0	0x00

<U, V>

Each component has 8bit data. The data type is "Straight Binary".

	Signal level (Decimal)	Data (Hexadecimal)
Highest (+)	127	0xFF
	126	0xFE
	:	:
	1	0x81
Lowest	0	0x80
	-1	0x7F
	:	:
	-127	0x01
Highest (-)	-128	0x00

< Y(Mono16) >

Y component has 16bit data. The data type is "Unsigned Short (big-endian)".

Y	Signal level (Decimal)	Data (Hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	:	:
	1	0x0001
Lowest	0	0x0000

Table 23: Data structure: Source: IIDC v. 1.3 specification

8 Description of the data path

8.1 Block diagrams of the cameras

The following diagrams illustrate the data flow and the bit resolution of image data after being read from the CCD or CMOS sensor chip in the camera. The individual blocks are described in more detail in the following paragraphs.

8.1.1 Black and white cameras:

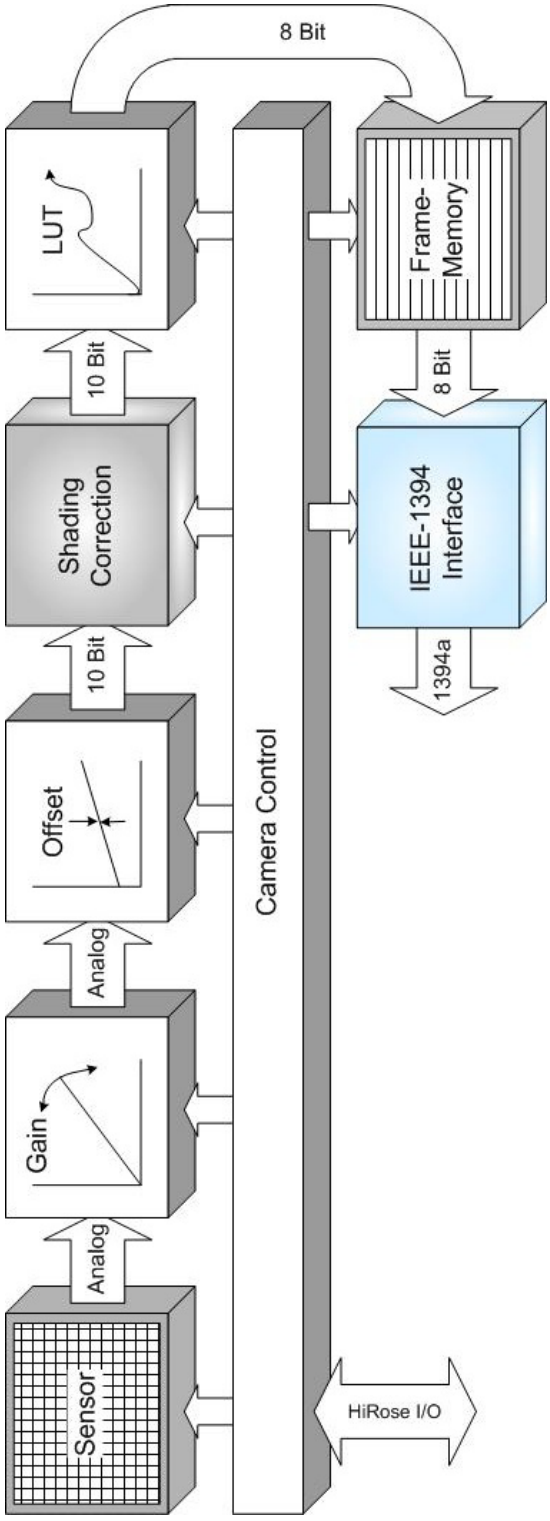


Figure 24: Block diagram b/w camera

8.1.2 Color cameras:

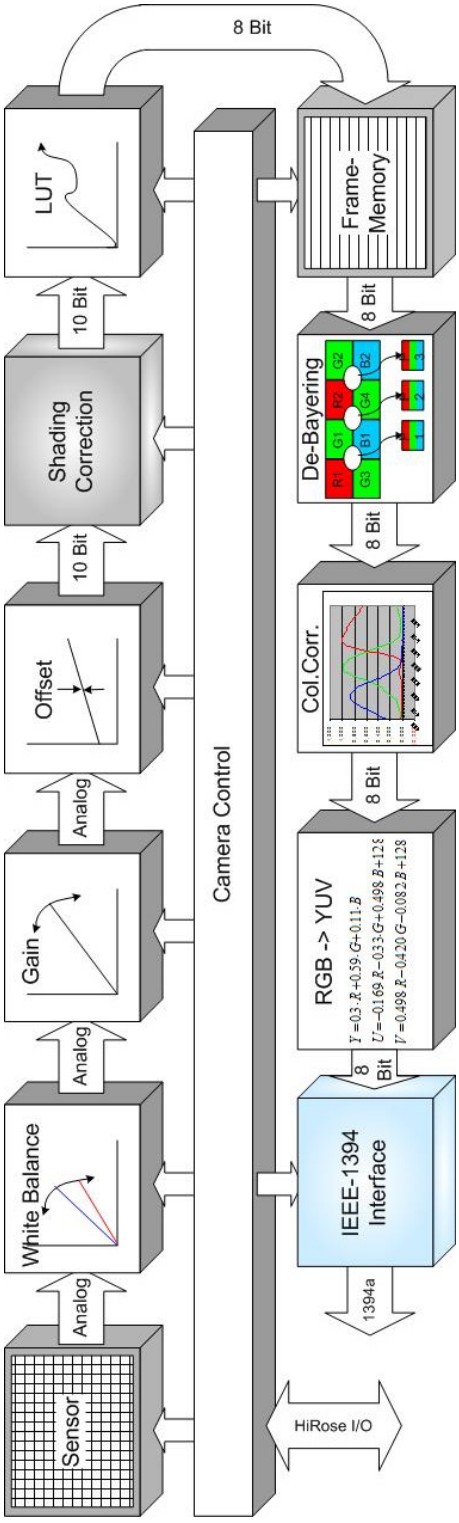


Figure 25: Block diagram color camera

8.2 Sensor

The Marlin family is equipped with various sensor types and resolutions. Both CCD and CMOS types are available in color and monochrome .

The following table gives an overview:

Model	Techn.	Manu-facturer	Sensor Type	Sensor Size	Micro-lens	Chip Size [mm]	Pixel Size [µm]	Eff. Pixels
MF-033B	CCD	SONY	ICX-414AL	½" (8 mm)	Yes, HAD	7.48 x 6.15	9.9 x 9.9	659 x 494
MF-033C	CCD	SONY	ICX-414AQ	½" (8 mm)	Yes, HAD	7.48 x 6.15	9.9 x 9.9	659 x 494
MF-046B	CCD	SONY	ICX-415AL	½" (8 mm)	Yes, HAD	7,48 x 6.15	8.3 x 8.3	782 x 582
MF-046C	CCD	SONY	ICX-415AQ	½" (8 mm)	Yes, HAD	7.48 x 6.15	8.3 x 8.3	782 x 582
MF-080B	CCD	SONY	ICX-204AL	1/3" (6 mm)	Yes, HAD	5.8 x 4.92	4.65 x 4.65	1034 x 779
MF-080C	CCD	SONY	ICX-204AK	1/3" (6 mm)	Yes, HAD	5.8 x 4.92	4.65 x 4.65	1034 x 779
MF-145B2	CCD	SONY	ICX-205AL	½" (8 mm)	Yes, HAD	7.6 x 6.2	4.65 x 4.65	1392 x 1040
MF-145C2	CCD	SONY	ICX-205AK	½" (8 mm)	Yes, HAD	7.6 x 6.2	4.65 x 4.65	1392 x 1040
MF-131B	CMOS	FillFactory	IBIS5A	2/3" (11 mm)	Not needed	8.6 x 6.9	6.7 x 6.7	1280 x 1024

Table 24: Sensor data

8.2.1 IBIS5A multiple slope

The MF-131 sensor has a high dynamic range of about 60 dB. This can be further extended to almost 100 dB by switching to a special mode..
This is called dual (in the case of rolling shutter) or multiple slope mode (in the case of global shutter).
The following diagram taken from FillFactory's application note, explains the functionality.

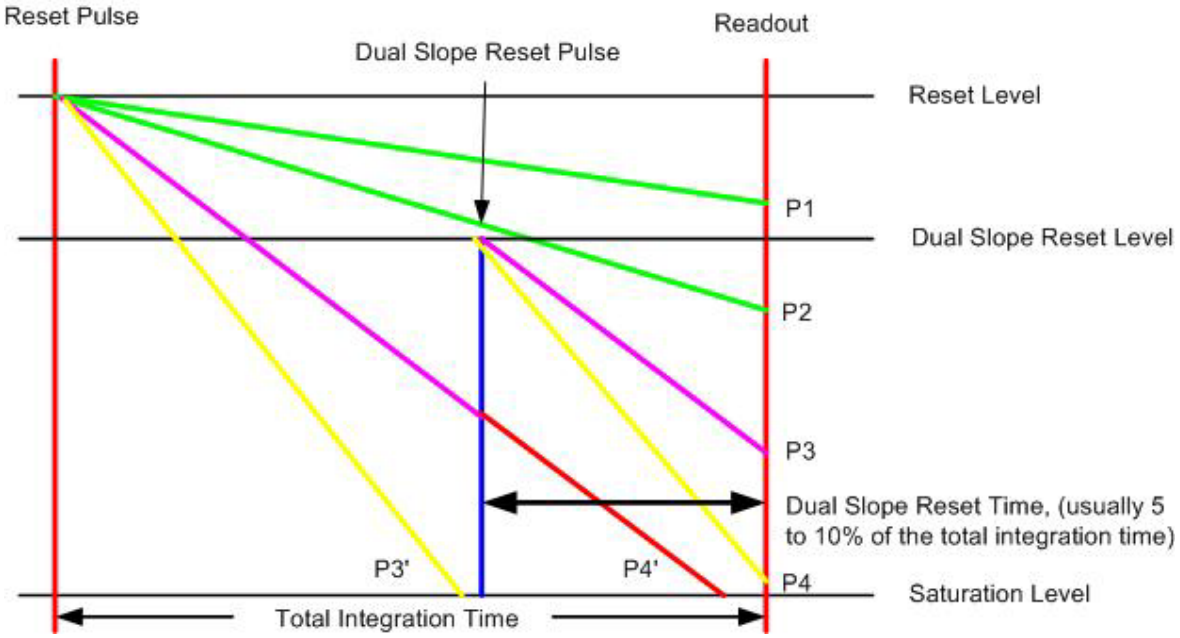


Figure 26: Multiple slope (high dynamic range)

The colored lines represent the analogue signal on the photodiode which decrease as a resultof exposure. The slope is determined by the amount of light at each pixel (the more light, the steeper the slope). When the pixels reach the saturation level, the analogue signal will no longer change despite further exposure. As shown in the diagram, without any dual or multiple slope pulse, pixels P3' and P4' reach saturation before the sample moment of the analogue values.

When dual slope is enabled, a second reset pulse will be given (blue line) at a certain time before the end of the integration time.
This dual slope reset pulse resets the analogue signal of the pixels below the dual slope reset level to this level. After the reset, the analogue signal starts to decrease with the same slope as before (pink P3 and yellow P4 lines).
This introduces a knee-point in the exposure function.
If the dual slope reset pulse is placed at the end of the integration time (90% for instance), the analogue signal that would have reached the saturation levels is no longer saturated (which increases the optical dynamic range) at read out.

It is important to notice that pixel signals above the dual slope reset level will not be influenced at all (green P1 and green P2).

The Marlin F131 offers two knee-points when in rolling shutter mode, and up to three knee-points when in global shutter mode. This functionality is basically controlled via the following registers.

Offset	Name	Field	Bit	Description
0xF1000280	HDR_CONTROL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	
		ON_OFF	[6]	Enable/disable HDR mode
		---	[7..19]	
		MaxKneePoints	[20…23]	Number of knee-points possible in this mode
		---	[24..27]	
		KneePoints	[28..31]	Number of active knee-points
0xF1000284	KNEEPOINT_1	---	[0..15]	
0xF1000284		Kneepoint1	[16..31]	Time in µs
0xF1000288	KNEEPOINT_2	---	[0..15]	
0xF1000288		Kneepoint2	[16..31]	Time in µs
0xF100028C	KNEEPOINT_3	---	[0..15]	
0xF100028C		Kneepoint3	[16..31]	Time in µs

Table 25: High dynamic range configuration register

ⓘ It is recommended that knee-points be adjusted to 10 %, 5 % and 2.5 % of the total exposure or shutter time.

Example:

Adjust image so that the dark areas are well displayed. Calculate the used shutter time. Activate HDR-Mode.
Assuming shutter time to be 40 ms = 40,000 µs:

⇨ Kneepoint_1 = 10 % * 40,000 µs = 4,000 µs = 0xFA0
⇨ Kneepoint_2 = 5 % * 40,000 µs = 2,000 µs = 0x7D0
⇨ Kneepoint_3 = 2.5 % * 40,000 µs = 1,000 µs = 0x3E8

The following needs to be written:

HDR_CONTROL:	(Adress: 0xF1000280)	0x02000003
KNEEPOINT_1:	(Adress: 0xF1000284)	0x00000FA0
KNEEPOINT_2:	(Adress: 0xF1000288)	0x000007D0
KNEEPOINT_3:	(Adress: 0xF100028C)	0x000003E8

For further tuning, readjust KNEEPOINT_X but maintain ratio KNEEPOINT_1 > KNEEPOINT_2 > KNEEPOINT_3

8.3 White balance

The color cameras have both manual and automatic white balance and can be set via the analog red and blue gain in the 0...+12 dB range. White balance is used so that non-colored image parts are displayed non-colored.

These settings are made in register 80Ch of IIDC v. 1.3. The values in the *V_Value/R_Value* field produce changes in the gain from green to red and in the *U_Value/B_Value* field from green to blue.

8.3.1 Automatic white balance

Automatic white balance is activated by setting the "One Push" bit in the WHITE_BALANCE register (see WHITE-BALANCE). The camera independently inputs frames and calculates the U/B and V/R correction values on the basis of 16x16 pixels from the center of the currently set frame. For white balance, incoming frames are input based on the current settings of all registers (GAIN, OFFSET, SHUTTER, etc.).

The following ancillary conditions should be observed for successful white balance:

- All pixels in the 16x16 calculation window must have a gray value <255 and the object in the calculation window must be monochrome.
- Automatic white balance can be started both during active image capture and when the camera is in idle state.

If the image capture is active (e.g. "IsoEnable" set in register 614h), the frames used by the camera for white balance are also output on the 1394 bus. Any previously active image capture is started again after the completion of white balance.
Automatic white balance can also be started by using an external trigger. However, if there is a pause of >10 seconds between capturing individual frames this process is aborted.

The following flow diagram illustrates the automatic white balance sequence.

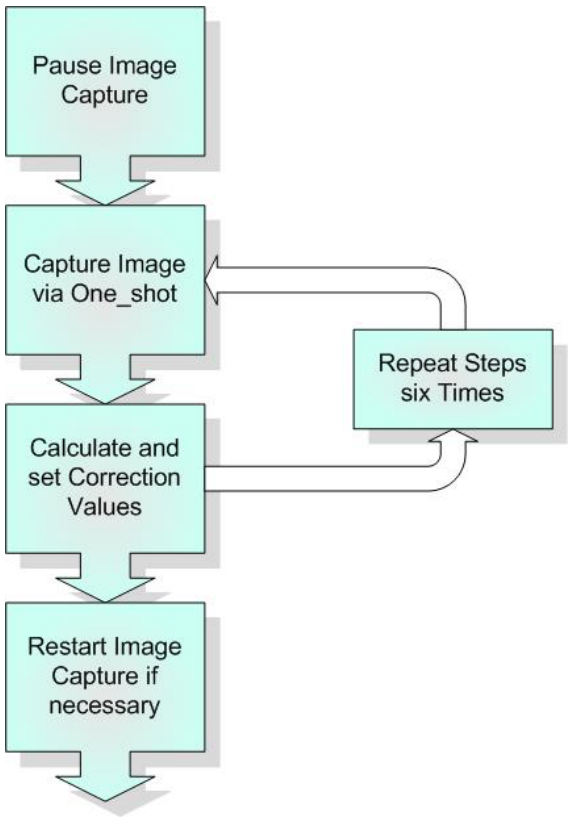

Pause Image Capture
Capture Image via One_shot
Repeat Steps six Times
Calculate and set Correction Values
Restart Image Capture if necessary

Figure 27: Automatic white balance sequence

Finally, the calculated correction values can be read from the WHITE_BALANCE register 80Ch.

8.4 Manual gain

The following ranges can be used when manually setting the gain for the analog video signal:

B/W CCD-cameras:	0 ... 24 dB	Color CCD-cameras:	0 ... 16 dB
B/W CMOS camera:	0 ... 13.5 dB		

The increment length is ~0.0354 dB/step for CCD-models and 1.25 dB for CMOS.
Thus the values to be entered will be within the following ranges:

B/W CCD-cameras:	0 ... 680	Color CCD-cameras:	0 ... 450
B/W CMOS camera:	0 ... 8		

ⓘ Setting the gain does not change the offset (black value).
ⓘ Higher gain also produces greater image noise. This reduces image quality. For this reason, try to increase the brightness first, using the aperture of the camera optics and shutter settings.

8.5 Setting the offset (black level)

It is possible to set the black value in the camera within the following ranges:

CCD-models: 0...+16 gray values (@ 8 bit). Increments are in 1/16 LSB (@ 8 bit).
CMOS-model: 0 ... +127 (@ 8 bit)
The formula for gain and offset setting is: Y`= GxY+0

8.6 Lookup tables (LUT)

The camera provides one user-defined LUT. This is also used for the gamma correction. The lookup table converts the 10 bits from the digitizer to 8 bits.
The use of a LUT allows you to store any function in the form Output = F(Input) in the RAM of the camera and to use it on the individual pixels of the frame at run-time.
The values of functions are calculated within a specific range and the input value is used as an index in the table.
The AVT Marlin can temporarily store 1 LUT in the camera. One example of such an LUT is the Gamma LUT: Output = $(\text{Input})^{0.45}$

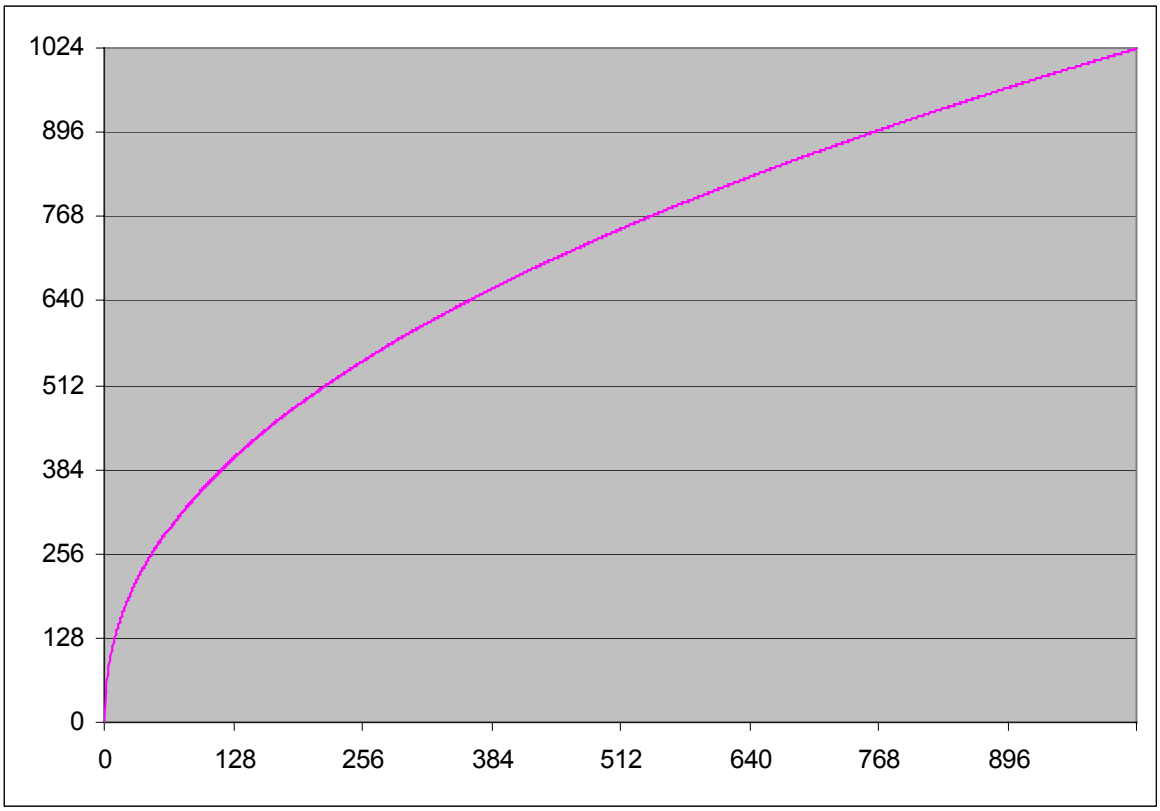


Figure 28: Gamma LUT

ⓘ The input value is the 10-bit value from the digitizer. The LUT outputs the most significant 8 Bit.

ⓘ Because gamma correction is also implemented via the lookup table, it is not possible to use a different LUT when gamma correction is switched on.

8.6.1 Loading a LUT into the camera

Loading the LUT is carried out through the data exchange buffer called GPDATA_BUFFER. Because the buffer can hold a maximum of 2 kB and a complete LUT at 1024 x 8 bit (1 kB), programming can take place in a one block write step. The flow diagram on the next page shows the few steps required to load data into the camera.

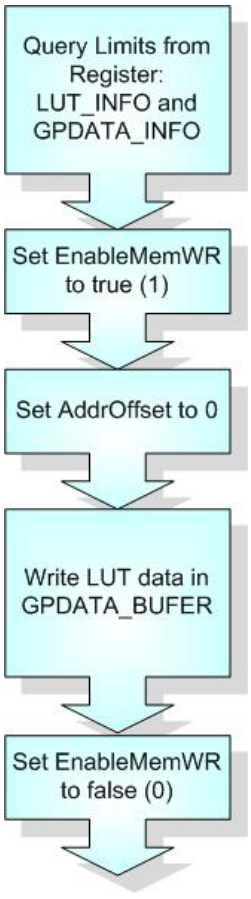

Query Limits from Register: LUT_INFO and GPDATA_INFO
Set EnableMemWR to true (1)
Set AddrOffset to 0
Write LUT data in GPDATA_BUFER
Set EnableMemWR to false (0)

Figure 29: Loading a LUT

The table below describes the registers required.

Offset	Name	Field	Bit	Description
0xF1000240	LUT_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Enable/Disable this feature
		---	[7..25]	-
		LutNo	[26..31]	Use Lookup table with number LutNo
0xF1000244	LUT_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		EnableMemWR	[5]	Enable write access
		---	[6..7]	
		AccessLutNo	[8..15]	
		AddrOffset	[16..31]	
0xF1000248	LUT_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	
		NumOfLuts	[8..15]	Max. # of Lookup tables
		MaxLutSize	[16..31]	Max. Lookup Table size

Table 26: LUT configuration register

8.7 Shading correction

Shading correction is used to compensate for non-homogeneities caused by lighting or optical characteristics within specified ranges. To correct a frame, a multiplier from 1...2 is calculated for each pixel in 1/256 steps – this allows for shading to be compensated by up to 50 %.

Besides generating shading data off-line and downloading it to the camera, the camera allows correction data to be generated automatically in the camera itself.
The following pictures describe the process of automatic generation of correction data. The line profiles were created using MVTEC's "ActivVision Tools".

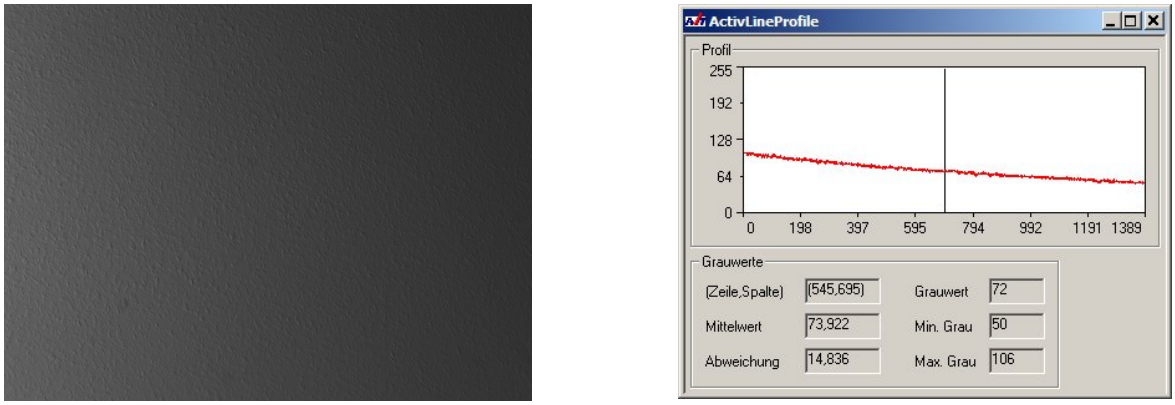


Figure 30: Shading correction: Source image with non-uniform illumination

On the left you see the source image with non-uniform illumination. The graph on the right clearly shows the brightness level falling off to the right.

The correction sequence controlled via "Directcontrol" uses the average of 16 frames (10H) to calculate the correction frame. By unfocussing the lens, high-frequency image data are removed from the source image, therefore its not included in the shading image.

8.7.1 Automatic generation of correction data

Requirements

Shading correction compensates for non-homogeneities by giving all pixels the same gray value as the brightest pixel. This means that only the background must be visible and the brightest pixel has a gray value of less than 255 when automatic generation of shading data is started.
It may be necessary to use a neutral white reference, e.g. a piece of paper, instead of the real image.

Algorithm

After the start of automatic generation, the camera pulls in the number of frames set in the GRAB_COUNT register. Recommended values are 4, 8 or 16. An arithmetic mean value is calculated from them (to reduce noise).

After this, a search is made for the brightest pixel in the mean value frame. A factor is then calculated for each pixel to be multiplied by, giving it the gray value of the brightest pixel.

All of these multipliers are saved in a “shading reference image“. The time required for this process depends on the number of frames to be calculated.
Correction alone can compensate for shading by up to 50 % and relies on 10 bit pixel data to avoid the generation of missing codes.

How to proceed:

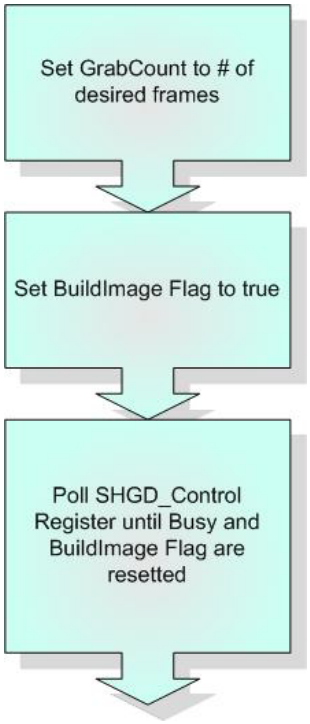

Set GrabCount to # of desired frames
Set BuildImage Flag to true
Poll SHGD_Control Register until Busy and BuildImage Flag are resetted

Figure 31: Automatic generation of a shading image

The table below describes the registers required.

Offset	Name	Field	Bit	Description
0xF1000250	SHDG_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	tbd
		---	[2..3]	
		ShowImage	[4]	Show shading data as image
		BuildImage	[5]	Build a new ShadingImage
		ON_OFF	[6]	Shading On/Off
		Busy	[7]	Build in progress
		---	[8..23]	
		GrabCount	[24..31]	Number of images
0xF1000254	SHDG_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		EnableMemWR	[5]	Enable write access
		EnableMemRD	[6]	Enable read access
		---	[7]	
		AddrOffset	[8..31]	
0xF1000258	SHDG_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	
		MaxImageSize	[8..31]	Max shading Image size

Table 27: Shading control register

ⓘ The maximum value of GRAB_COUNT depends on the type of camera and the number of existing frame buffers. GRAB_COUNT is also automatically corrected to the power of two.

ⓘ The SHDG_CTRL register should not be queried at very short intervals, because each query delays the generation of the shading image. A good interval time is 500 ms.

The following pictures illustrate the sequence of commands for the generation of the shading image. Shading corrected output image (unfocused lens):

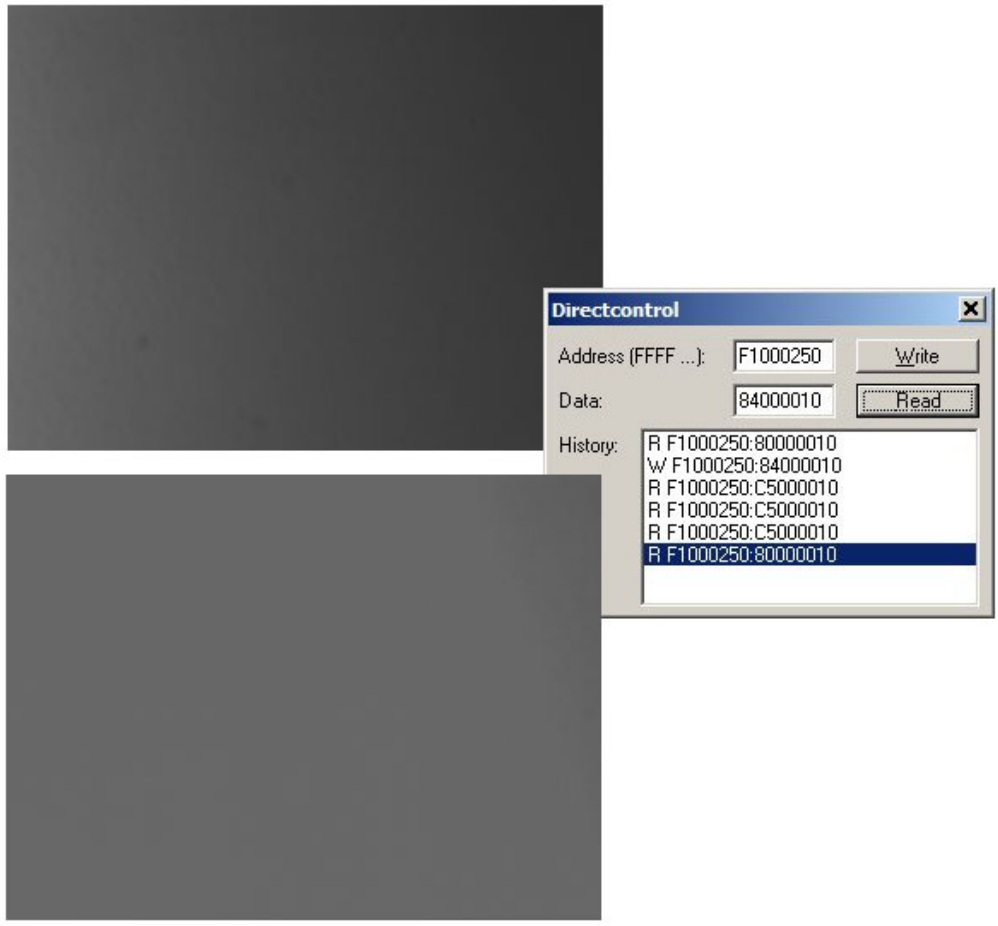


Figure 32: Generation of shading image

The calculation of shading data is always carried out at the current resolution set. If the Area of Interest (AOI) is bigger than the window in which correction data was being calculated, none of the pixels lying outside are corrected.
For Format_7 it is advisable to generate the shading image in the largest displayable frame format. This ensures that any smaller AOIs are completely shading corrected. The automatic generation of shading data can also be started when image capture is running. The camera then pauses the running image capture for the time needed for generation and resumes after generation is completed.

After the lens has been focused again you see the previous image, but now with a considerably more uniform gradient. This is also made apparent in the graph.

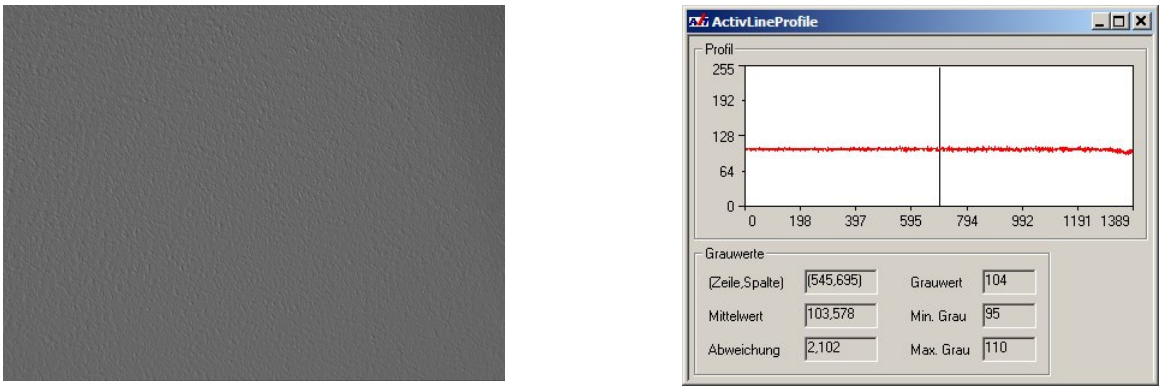


Figure 33: Example of shaded image

8.7.2 Loading a shading image into the camera

GPDATA_BUFFER is used to load a shading image into the camera. Because the size of a shading image is larger than GPDATA_BUFFER, input must be handled in several steps:

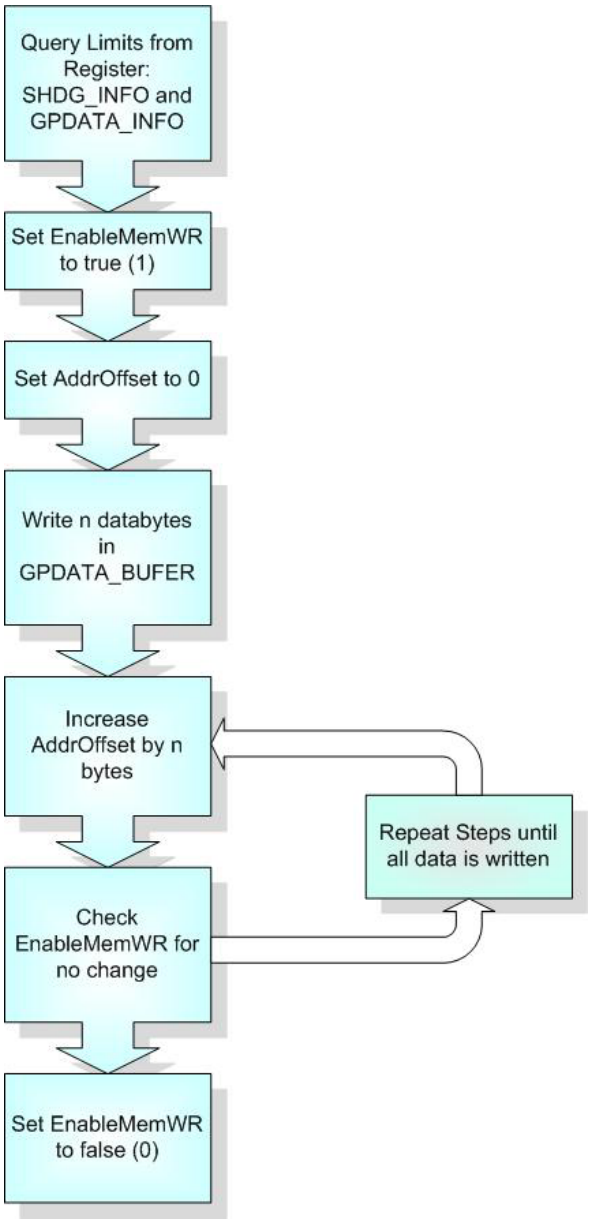

Query Limits from Register: SHDG_INFO and GPDATA_INFO
Set EnableMemWR to true (1)
Set AddrOffset to 0
Write n databytes in GPDATA_BUFER
Increase AddrOffset by n bytes
Repeat Steps until all data is written
Check EnableMemWR for no change
Set EnableMemWR to false (0)

Figure 34: Loading the shading reference image

8.8 Color interpolation and correction

In the sensors, used color information is captured via the primary color filters placed over the individual pixels in a "BAYER mosaic" layout. An effective Bayer -> RGB color interpolation already takes place in all Marlin color version cameras. Before converting to the YUV format, color correction is done after Bayer demosaicing.

8.8.1 Interpolation (BAYER demosaicing)

In interpolation a red, green or blue value is determined for each pixel. Only two lines are needed for this interpolation:

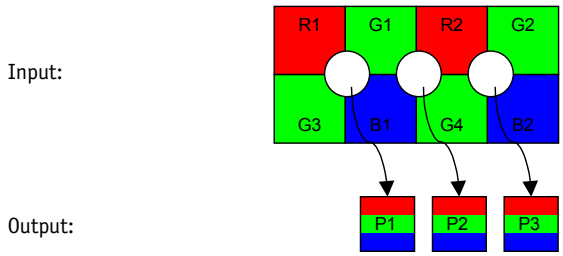


Figure 35: Bayer demosaicing (interpolation)

$$P1_{red} = R1 \qquad P2_{red} = R2 \qquad P3_{red} = R2$$
$$P1_{green} = \frac{G1+G3}{2} \qquad P2_{green} = \frac{G1+G4}{2} \qquad P3_{green} = \frac{G2+G4}{2}$$
$$P1_{blue} = B1 \qquad P2_{blue} = B1 \qquad P3_{blue} = B2$$

Color cameras begin outputting the image in line two and finish in line Y (maximum image height minus two). This is a side effect of BAYER demosaicing. The adjustable maximum image height is also two lines less than in the b/w variant.

ⓘ Please note that on the color camera, a black border one pixel wide forms on the left and right image borders. This is also a consequence of BAYER demosaicing as the image width displayed on the color camera is not scaled down.

8.8.2 Color correction

Color correction is calculated before YUV conversion and mapped via a matrix as follows.

$$red^* = Crr \cdot red + Cgr \cdot green + Cbr \cdot blue$$
$$green^* = Crg \cdot red + Cgg \cdot green + Cbg \cdot blue$$
$$blue^* = Crb \cdot red + Cgb \cdot green + Cbb \cdot blue$$

Sensor specific coefficients C_{xy} are scientifically generated to ensure that GretagMacbeth™ ColorChecker® colors are displayed with highest color fidelity and color balance.

ⓘ On the color camera color correction is also deactivated in Mono8 or Mono16 mode (raw image transport).

8.8.3 RGB → YUV conversion

The conversion from RGB to YUV is made using the following formulae:

$$Y = 0.3 \cdot R + 0.59 \cdot G + 0.11 \cdot B$$
$$U = -0.169 \cdot R - 0.33 \cdot G + 0.498 \cdot B + 128$$
$$V = 0.498 \cdot R - 0.420 \cdot G - 0.082 \cdot B + 128$$

9 Controlling image capture

The cameras support the SHUTTER_MODES specified in IIDC V1.3. For all CCD-models this shutter is a global shutter; meaning that all pixels are exposed to the light at the same moment and for the same time span.
In continuous modes the shutter is opened shortly before the vertical reset happens, thus acting in a frame-synchronous way.
Combined with an external trigger, it becomes asynchronous in the sense that it occurs whenever the external trigger occurs. Individual images are recorded when an external trigger impulse is present. This ensures that even fast moving objects can be grabbed with minimal image blur.
The external trigger is fed as a TTL signal through Pin 4 of the HiRose connector.

For CMOS sensors, a global shutter is not common. Therefore a rolling curtain shutter is used to shorten the exposure or integration time. The curtain's width defines the integration time and the curtain sweeps with the frame readout time over the image. Although this is appropriate for still images, image distortion will be created with moving objects, because the upper image part is scanned earlier than the lower image part.
The MF-131 features both rolling curtain and global shutter. By default, global shutter is used.
A side effect of global shutter is that the integration or shutter time is added to the readout time, thus affecting the frame rates to be achieved.

The cameras support Trigger_Mode_0 and Trigger_Mode_1.
Trigger_Mode_0 sets the shutter time according to the value set in the shutter (or extended shutter) register. Trigger_Mode_1 sets the shutter time according to the active low time of the pulse applied (or active high time in the case of an inverting input).

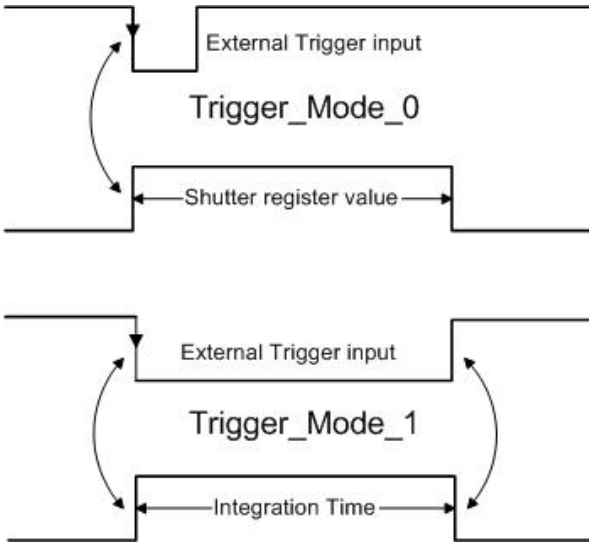


Figure 36: Trigger_modes

9.1 Exposure time

The exposure (shutter) time for continuous mode and Trigger_Mode_0 is based on the following formula:

Shutter register value x timebase + offset

The register value is the value set in the corresponding IIDC register (SHUTTER [81Ch]). This number is in the range between 1 and 4095.
The shutter register value is multiplied by the time base register value (see TIMEBASE). The default value here is set to 20 µs.

A camera-specific offset of 24 to 43 µs is also added to this value.

Example

Camera: MF-033
Register value: 100
Timebase: 20 µs

100 x 20 µs + 24 µs = 2024 µs exposure time.
The minimum adjustable exposure time set by register is 10 µs. => the real minimum exposure time of an MF-033 is then 10 µs + 24 µs = 34 µs.

9.1.1 Extended shutter

The exposure time for long-term integration of up to 67 sec can be extended via the EXTENDED_SHUTTER register.

Offset	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1.. 5]	
		ExpTime	[6..31]	Exposure time in µs

Table 28: Extended shutter configuration

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

- ⓘ Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- ⓘ Longer integration times not only increase sensitivity, but also may increase some unwanted effects such as noise and pixel-to-pixel nonuniformity. Depending on the application, these effects may limit the longest useable integration time.
- ⓘ Changes in this register have immediate effect, even when the camera is transmitting.
- ⓘ Extended shutter becomes inactive after writing to a format/mode/framerate register.

9.2 One-Shot

The camera can record an image by setting "`OneShot`" in the 61Ch register. This bit is automatically cleared after the image is captured. If the camera is placed in *Iso_Enable* mode (see ISO_Enable / Free-Run), this flag is ignored.
If *OneShot mode* is combined with the external trigger, the "`OneShot`" command is used to arm it. The following screenshot shows the sequence of commands needed to put the camera into this mode. It enables the camera to grab exactly one image with an external trigger edge.
If there is no trigger impulse after the camera has been armed, OneShot can be cancelled by clearing the bit.

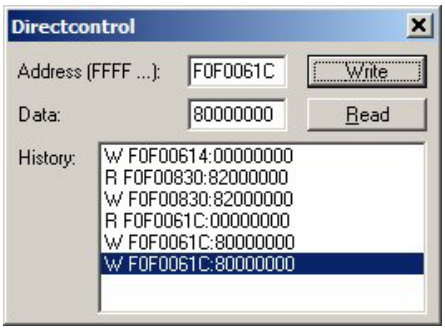


Figure 37: One_shot control

9.2.1 OneShot command on the bus to start of exposure

The following sections describe the time response of the camera using a single frame (OneShot) command. As set out in the IIDC specification, this is a software command that causes the camera to record and transmit a single frame.

The following values apply only under the condition that the camera is in idle and ready for use. Full resolution must also be set.

OneShot->Microcontroller-Sync: <=500 µs (processing time in the microcontroller)

µC-Sync/ExSync->Integration-Start 8 µs

Microcontroller-Sync is an internal signal. It is generated by the microcontroller to initiate a trigger. This can either be a direct trigger or a release for ExSync if the camera is triggered externally.

9.2.2 End of exposure to first packet on the bus

After the exposure, the CCD or CMOS-sensor is read out; some data is written into the FRAME_BUFFER before being transmitted to the bus.

The time from the end of exposure to the start of transport on the bus is:

500µs ± 62.5µs

This time jitters with the cycle time of the bus (125µs).

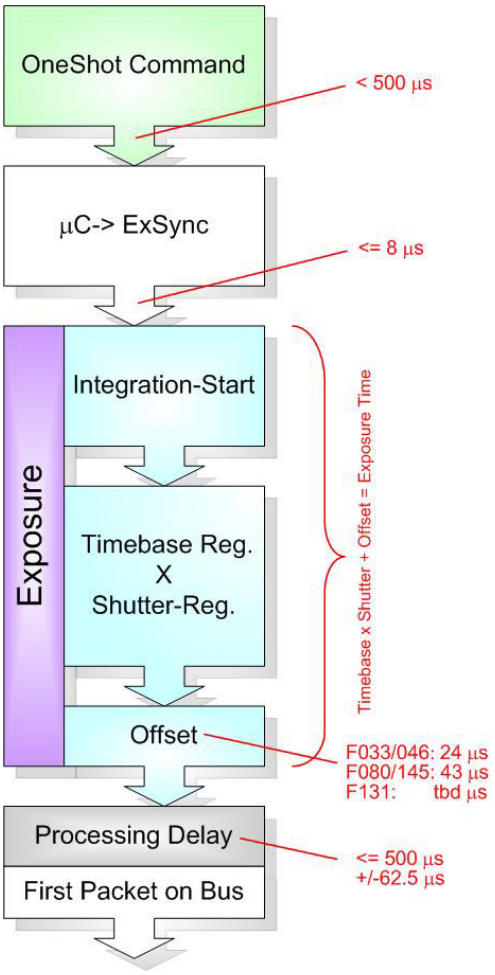


Figure 38: Data flow and timing after end of exposure

9.3 Multi-Shot

Setting "`MultiShot`" and entering a quantity of images in *Count_Number* in the 61Ch register enables the camera to record a specified number of images.

The number is indicated in bits 16 to 31. If the camera is put into *Iso_Enable* mode (ISO_Enable / Free-Run), this flag is ignored and deleted automatically once all the images have been recorded.

If *MultiShot* mode is activated and the images have not yet all been captured, it can be quit by resetting the flag. The same can be achieved by setting the number of images to "0".

Multi-Shot can also be combined with the external trigger in order to grab a certain number of images based on an external trigger. This is especially helpful in combination with the socalled Deferred_Mode to limit the amount of grabbed images to the FIFO size.

9.4 ISO_Enable / Free-Run

Setting the MSB (bit 0) in the 614h register (ISO_ENA) puts the camera into *ISO_Enable mode* or *Continuous_Shot*. The camera captures an infinite series of images. This operation can be quit by deleting the "0" bit.

9.5 Asynchronous broadcast

The camera accepts asynchronous broadcasts. This involves asynchronous write requests that use node number 63 as the target node with no acknowledge.

This makes it possible for all cameras on a bus to be triggered by software simultaneously - e.g. by broadcasting a "`One_Shot`". All cameras receive the "`One_Shot`" command in the same IEEE-1394 bus cycle. This creates uncertainty for all cameras in the range of 125 µs.
Inter-camera latency is described in chapter 7.6.
The following screenshot shows an example of broadcast commands sent with the Firedemo example of FirePackage (version 1V42):
Line 1 shows the broadcast command, which stops **all** cameras connected to the same IEEE-1394 bus. It is generated by holding the <`shift`> key down while clicking on <`Write`>.
Line 2 generates a "`broadcast One_Shot`" in the same way, which forces all connected cameras to simultaneously grab one image.

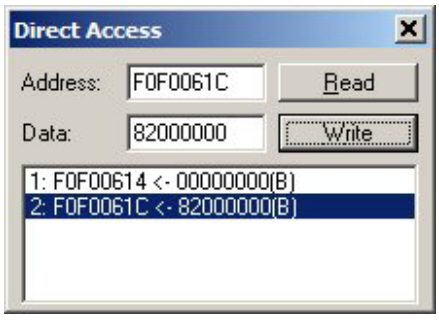


Figure 39: Broadcast One_Shot

9.6 Jitter at start of exposure

The following chapter discusses the latency time which exists for all CCD-models when either a hardware or software trigger is generated, until the actual image exposure starts.
Owing to the well-known fact that an Interline Transfer CCD-sensor has both a light sensitive area and a separate storage area, it is common to interleave image exposure of a new frame and output that of the previous one. It makes continuous image flow possible, even with an external trigger.
This is different to the way the CMOS- sensor of the MF-131 works: the image sensitive area is also the storage area, which means that it cannot be used for the integration of the new frame until it has been read out.
Continuous image flow is thus only possible with the so-called rolling shutter.
Asynchronous image aqquisition only makes sense with the global shutter; leading to a non-interleaving exposure – readout – exposure sequence. For every exposure cycle the sensor is completely reset so that the camera needs to be idle.
For the CCD's the uncertain time delay before the start of exposure depends on the state of the sensor. A distinction is made as follows:

FVal is active → the sensor is reading out, camera is busy

In this case the camera must not change horizontal timing so that the trigger event is synchronized with the current horizontal clock. This introduces a max. uncertainty which is equivalent to the line time. The line time depends on the sensor used and therefore can vary frommodel to model.

FVal is inactive → the sensor is ready, the camera is idle

In this case the camera can resynchronize the horizontal clock to the new trigger event, leaving only a very short uncertainty time of the master clock period.

Model	Camera idle	Camera busy
MF-033	33,33 ns	27,03 µs
MF-046	33,33 ns	32,17 µs
MF-080	50 ns	63,50 µs
MF-131	25 ns	Not possible
MF-145	50 ns	92,25 µs

Table 29: Jitter at exposure start

- Jitter at the beginning of an exposure has no effect on the length of exposure, i.e. it is always constant.
- By default, the MF-131, the CMOS sensor uses global shutter, so it cannot be re-triggered until the previous image has been read out.

9.7 Frame memory and deferred image transport

An image is normally captured and transported in consecutive steps. The image is taken, read out from the sensor, digitized and sent over the 1394 bus.
As all Marlin cameras are equipped with builtin image memory, this order of events can be paused or delayed by using the *deferred image transport* feature.
Marlin cameras are equipped with 8 MB of RAM. The table below shows how many frames can be stored by each model. The memory is arranged in a FiFo (First in First out) manner. This makes addressing for individual images unnecessary.

Model	Memory Size
MF-033	13 frames
MF-046	13 frames
MF-080	7 frames
MF-131	4 frames
MF-145	3 frames

Table 30: FiFo memory size

Deferred image transport is especially useful for multi camera applications where a multitude of cameras grab a certain number of images without having to take available bus bandwidth,DMA- and ISO-channels into account. Image transfer is controlled from the host computer by addressing individual cameras and reading out the desired number of images. Functionality is controlled by the following register:

Offset	Name	Field	Bit	Description
0xF1000260	DEFERRED_TRANS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		SendImage	[5]	Send NumOfImages now (auto reset)
		HoldImg	[6]	Enable/Disable deferred transport mode
		FastCapture	[7]	Enable/disable fast capture mode
		---	[8..15]	
		FiFoSize	[16..23]	Size of FiFo in number of images (read only)
		NumOfImages	[24..31]	W: Number of images to send R: Number of images in buffer

Table 31: Deferred mode configuration register

9.7.1 HoldImg mode

By setting the *HoldImg* flag, transport of the image over the 1394 bus is stopped completely. All captured images are stored in the internal ImageFiFo. The camera reports the maximum possible number of images in the FiFoSize variable.

- Pay attention to the maximum number of images that can be stored in FiFo. If you capture more images than the number in FiFoSize, the oldest images are overwritten.
- The extra *SendImage* flag is set to “true” to import the images from the camera. The camera sends the number of images that are entered in the *NumOfImages* parameter.
- If *NumOfImages* is “0” all images stored in FIFO are sent.
- If *NumOfImages* is not “0”, the corresponding number of images is sent.
- If the *HoldImg* field is set to “false”, all images in *ImageFIFO* are deleted. No images are sent.

The following screenshot displays the sequence of commands needed to work with deferred mode.

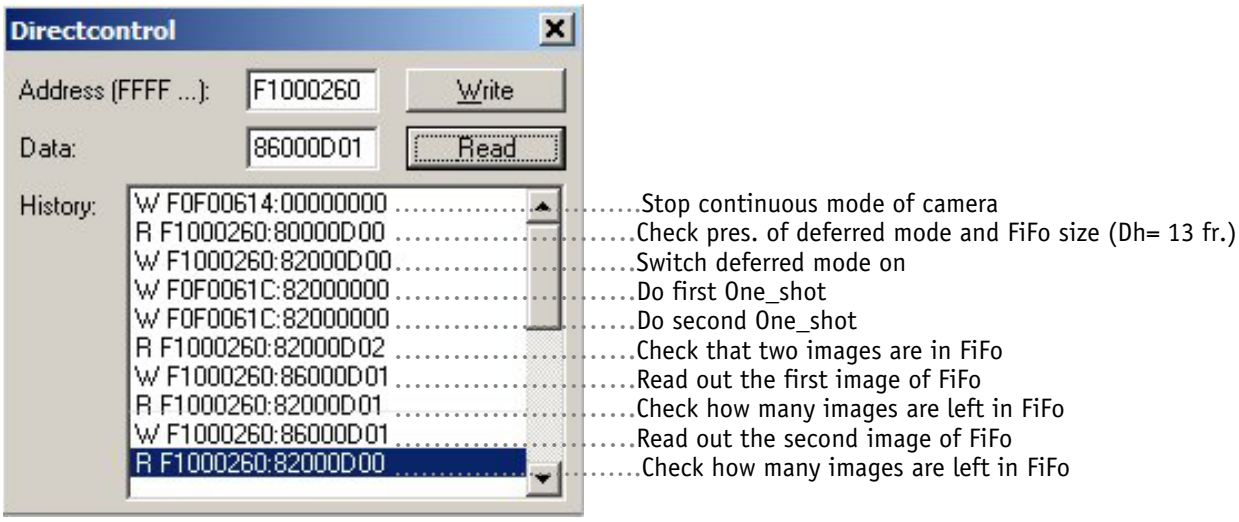

Directcontrol
Address (FFFF ...):
F1000260
Write
Data:
86000D01
Read
History:
W F0F00614:00000000 .....Stop continuous mode of camera
R F1000260:80000D00 .....Check pres. of deferred mode and FiFo size (Dh= 13 fr.)
W F1000260:82000D00 .....Switch deferred mode on
W F0F0061C:82000000 .....Do first One_shot
W F0F0061C:82000000 .....Do second One_shot
R F1000260:82000D02 .....Check that two images are in FiFo
W F1000260:86000D01 .....Read out the first image of FiFo
R F1000260:82000D01 .....Check how many images are left in FiFo
W F1000260:86000D01 .....Read out the second image of FiFo
R F1000260:82000D00 .....Check how many images are left in FiFo

Figure 40: Example of controlling deferred mode

9.7.2 FastCapture

This mode can be activated only in Format_7.

When *FastCapture* is set to "false", the maximum frame rate both for image acquisition and read out is associated with the packet size set in the BYTE_PER_PACKET register. The lower this value is, the lower the attainable frame rate is.

By setting *FastCapture* to "true", all images are recorded at the highest possible frame rate, i.e. the setting above does not affect the frame rate for the image intake but only the read out. This mode is ideal for applications where a burst of images need to be recorded at the highest sensor speed but the output can be at a lower frame frequency to save bandwidth.

9.8 Sequence mode

This mode enables certain image settings to be adjusted differently for every image, e.g. gain and shutter can be changed on the fly by the host computer by writing into the gain and shutter register even while the camera is running. An uncertainty of one image remains because normally the host does not know (especially with external trigger) when the next image will arrive. In this concept the host needs to take control over the timing and in deciding when to change a setting.

Sequence mode is a concept where the camera holds a set of different image parameters for a sequence of images. The parameter set is stored in the camera for each image to be recorded. This sequence of parameter sets is simply called a sequence. The advantage is that the camera can easily synchronize this parameter set with the images so that no uncertainty can occur.

Examples:
For a sequence of images, each image can be recorded with a different shutter or gain to obtain different brightness effects.
The image area (AOI) of a sequence of images can automatically be modified, thus creating a panning or sequential split screen effect.

The following registers can be modified to affect the individual steps of the sequence.

All modes	Cur_V_Mode, Cur_V_Format, ISO_Channel, ISO_Speed, Brightness, White_Balance (color cameras only), Shutter, Gain, Lookup-Table, TestImage
Fixed modes only	Cur_V_Frm_Rate
Format_7 only	Image_Position, Image_Size, Color_Coding_ID, Byte_Per_Packet

Table 32: Registers to be modified within a sequence

9.8.1 How is sequence mode implemented?

There is a FIFO (first in first out) memory for each of the IIDC v. 1.3 registers listed above. The depth of each FIFO is determined by the maximum number of images contained in the sequence. Functionality is controlled by the following advanced registers.

Offset	Name	Field	Bit	Description
0xF1000220	SEQUENCE_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		AutoRewind	[5]	
		ON_OFF	[6]	Enable/Disable this feature
		---	[7..15]	
		MaxLength	[16..23]	Max possible length of a sequence (read only)
		SeqLength	[24..31]	Length of the sequence
0xF1000224	SEQUENCE_PARAM	---	[0..4]	
		ApplyParameters	[5]	Apply settings to selected image of sequence; auto-reset
		IncImageNo	[6]	Increment ImageNo after ApplyParameters has finished
		---	[7..23]	
		ImageNo	[24..31]	Number of image within a sequence

Table 33: Sequence configuration register

The following flow diagram shows how to set up a sequence.

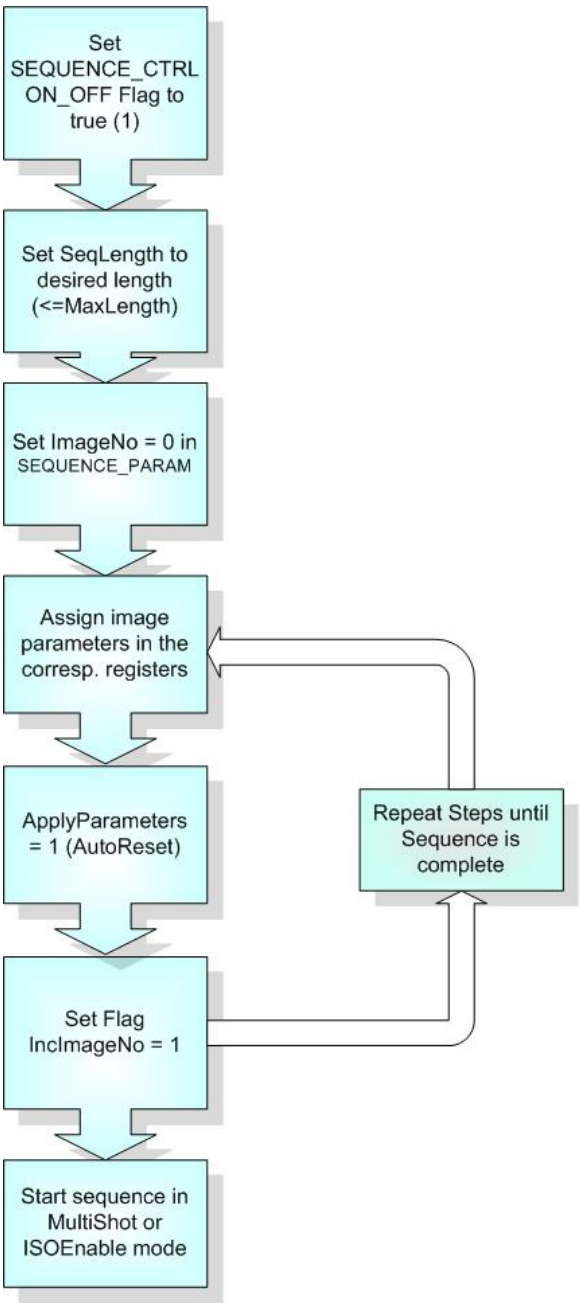

Set SEQUENCE_CTRL ON_OFF Flag to true (1)
Set SeqLength to desired length (<=MaxLength)
Set ImageNo = 0 in SEQUENCE_PARAM
Assign image parameters in the corresp. registers
ApplyParameters = 1 (AutoReset)
Repeat Steps until Sequence is complete
Set Flag IncImageNo = 1
Start sequence in MultiShot or ISOEnable mode

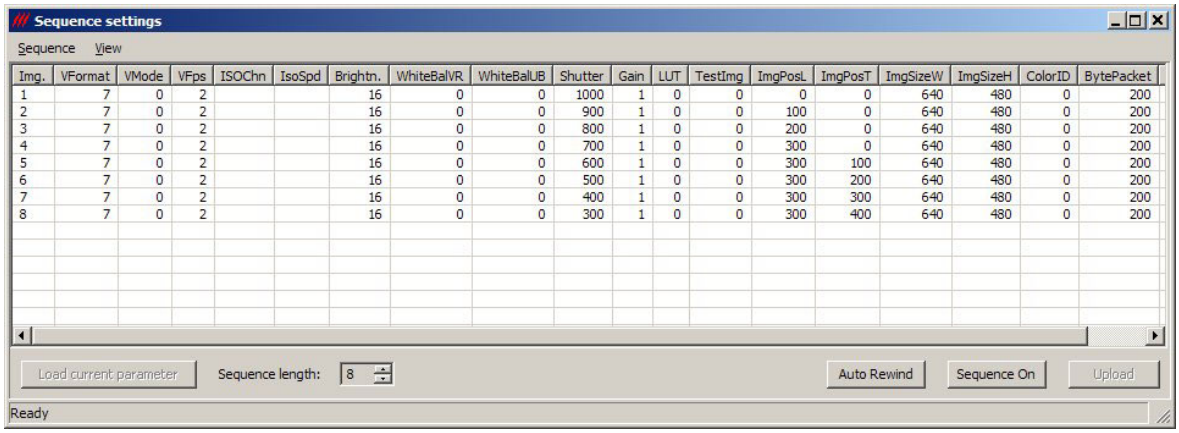
Figure 41: Sequence mode flow diagram

During sequencing, the camera obtains the required parameters, image by image, from the corresponding FIFOs (e.g. information for exposure time).

What to pay attention to when working with a sequence:

- If more images are recorded than defined in *SeqLength* ,the settings for the last image remain in effect.
- If *sequence* mode is cancelled, the camera can use the FIFO for other tasks. For this reason, a sequence must be loaded back into the camera after *sequence* mode has been cancelled.
- To repeat the sequence, stop the camera and send the "MultiShot" or "IsoEnable" command again. Each of these two commands resets the sequence.
- Using *SingleShot* mode in combination with a sequence does not make sense, because *SingleShot* mode restarts the sequence every time.
- The sequence may not be active when setting the *AutoRewind* flag. For this reason it is important to set the flag before the "MultiShot" or "ISO_Enable" commands.
- If the sequence is used with the *deferred transport* feature, the number of images entered in *Seq_Length* may not be exceeded.

The following screenshot shows an example of a sequence for eight different image settings. It uses the AVT program AVTFiretool as graphical representation. Please note the changes in the shutter time, which create descending image brightness, and the change in the image position, which creates a panning effect.



Img.	VFormat	VMode	VFps	ISOChn	IsoSpd	Brightn.	WhiteBalVR	WhiteBalUB	Shutter	Gain	LUT	TestImg	ImgPosL	ImgPosT	ImgSizeW	ImgSizeH	ColorID	BytePacket
1	7	0	2			16	0	0	1000	1	0	0	0	0	640	480	0	200
2	7	0	2			16	0	0	900	1	0	0	100	0	640	480	0	200
3	7	0	2			16	0	0	800	1	0	0	200	0	640	480	0	200
4	7	0	2			16	0	0	700	1	0	0	300	0	640	480	0	200
5	7	0	2			16	0	0	600	1	0	0	300	100	640	480	0	200
6	7	0	2			16	0	0	500	1	0	0	300	200	640	480	0	200
7	7	0	2			16	0	0	400	1	0	0	300	300	640	480	0	200
8	7	0	2			16	0	0	300	1	0	0	300	400	640	480	0	200

Figure 42: Example of sequence mode settings

9.8.2 Changing the parameters within a sequence

To change the parameter set for one image, it is not necessary to make settings for the entire sequence. The image can simply be selected via the *ImageNo* field and it is then possible to change the corresponding IIDC v. 1.3 registers.

What to pay attention to when changing the parameters:

- If the *ApplyParameters* flag is used when setting the parameters, all not-configured values are set to default values. As changing a sequence normally affects only the value of a specific register, and all other registers should not be changed, the *ApplyParameters* flag may not be used here.
- The values stored for individual images can no longer be read.
- If the camera is switched into *sequence mode*, the changes to the IIDC v. 1.3 registers for the image specified in *ImageNo* take immediate effect.
- Changes in the image size and the BytePacket settings need to be mirrored in the host computer when using e.g. FirePackage, as they affect the amount of data, and the number of packets to be sent for one image, and thus the creation of new image-events.

10 Video formats, modes and bandwidth

The different Marlin models support different video formats, modes and frame rates.
These formats and modes are standardized in the IIDC (formerly DCAM) specification.
Resolutions smaller than the generic sensor resolution are generated from the center of the sensor and without binning.

10.1 MF-033B/ MF-033C

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps[1]
0	0	160 x 120 YUV444						
	1	320 x 240 YUV422						
	2	640 x 480 YUV411	x	x	x	x	x	
	3	640 x 480 YUV422		x	x	x	x	
	4	640 x 480 RGB						
	5	640 x 480 MONO 8	x	x	x	x	x	
	6	640 x 480 MONO 16						

7	0	656x 494 MONO8 656 x 492 YUV	@74 fps @51(YUV:4:2:2)/68(YUV:4:1:1) fps

Table 34: Video formats MF-033

10.2 MF-046B/ MF-046C

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps[1]
0	0	160 x 120 YUV444						
	1	320 x 240 YUV422						
	2	640 x 480 YUV411		x	x	x	x	
	3	640 x 480 YUV422		x	x	x	x	
	4	640 x 480 RGB						
	5	640 x 480 MONO 8		x	x	x	x	
	6	640 x 480 MONO 16						

7	0	780 x 582 MONO8 780 x 580 YUV	@53 fps @36(YUV:4:2:2)/49(YUV:4:1:1) fps

Table 35: Video formats MF-046

Owing to color interpolation, the maximum height is two lines less than b/w and the first and last pixel columns contain no image information.

10.3 MF-080B/ MF-080C

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps[1]
0	0	160 x 120 YUV444						
	1	320 x 240 YUV422						
	2	640 x 480 YUV411			x	x	x	
	3	640 x 480 YUV422			x	x	x	
	4	640 x 480 RGB						
	5	640 x 480 MONO8			x	x	x	
	6	640 x 480 MONO16						
1	0	800 x 600 YUV422			x	x	x	
	1	800 x 600 RGB						
	2	800 x 600 MONO8			x	x	x	
	3	1024 x 768 YUV422			x	x	x	-
	4	1024 x 768 RGB						-
	5	1024 x 768 MONO8			x	x	x	-
	6	800 x 600 MONO16						
	7	1024 x 768 MONO16						
7	0	1032 x 778 MONO8 1032 x 776 YUV	@ 20 fps					

Table 36: Video formats MF-080

Owing to color interpolation, the maximum height is 1038 pixels and the first and last pixel columns contain no image information.

10.4 MF-145B/ MF-145C

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120 YUV444						
	1	320 x 240 YUV422						
	2	640 x 480 YUV411			x	x	x	
	3	640 x 480 YUV422			x	x	x	
	4	640 x 480 RGB						
	5	640 x 480 MONO 8			x	x	x	
	6	640 x 480 MONO 16						
1	0	800 x 600 YUV422			x	x	x	
	1	800 x 600 RGB						
	2	800 x 600 MONO8			x	x	x	
	3	1024 x 768 YUV422			x	x	x	
	4	1024 x 768 RGB						
	5	1024 x 768 MONO 8			x	x	x	
	6	800 x 600 MONO16						
	7	1024 x 768 MONO16						
2	0	1280 x 960 YUV422				x	x	x
	1	1280 x 960 RGB						
	2	1280 x 960 MONO 8				x	x	x
	3	1600 x 1200 YUV422						
	4	1600 x 1200 RGB						
	5	1600 x 1200 MONO						
	6	1280 x 960 MONO16						
	7	1600 x 1200 MONO16						
7	0	1392 x 1038 YUV411/422	@10 fps					
	1	1392 x 1040 MONO8	Raw Bayer pattern @10 fps					

Table 37: Video formats MF-145

Owing to color interpolation, the maximum height is 1038 pixels and the first and last pixel columns contain no image information.

10.5 MF-131B

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
0	0	160 x 120 YUV444						
	1	320 x 240 YUV422						
	2	640 x 480 YUV411						
	3	640 x 480 YUV422						
	4	640 x 480 RGB						
	5	640 x 480 MONO 8		x	x	x	x	
	6	640 x 480 MONO 16						
1	0	800 x 600 YUV422						
	1	800 x 600 RGB						
	2	800 x 600 MONO8		x	x	x	x	
	3	1024 x 768 YUV422						
	4	1024 x 768 RGB						
	5	1024 x 768 MONO 8			x	x	x	
	6	800 x 600 MONO16						
	7	1024 x 768 MONO16						
2	0	1280 x 960 YUV422						
	1	1280 x 960 RGB						
	2	1280 x 960 MONO 8			x	x	x	x
	3	1600 x 1200 YUV422						
	4	1600 x 1200 RGB						
	5	1600 x 1200 MONO						
	6	1280 x 960 MONO16						
	7	1600 x 1200 MONO16						
7	0	1280 x 1024 MONO8	@25 fps					

Table 38: Video formats MF-131

10.6 Area of interest (AOI)

The image sensor on the camera has a defined resolution. This indicates the maximum number of lines and pixels per line that the recorded image may have.

However, often only a certain section of the entire image is of interest. The amount of data to be transferred can be decreased by limiting the image to a section when reading it out from the camera. At a lower vertical resolution the sensor can be read out faster and thus the frame rate is increased.

ⓘ The setting of AOIs is supported only in video Format_7.

While the size of the image read out for most other video formats and modes is fixed by the IIDC specification, thereby determining the highest possible frame rate, in Format_7 mode the user can set the “upper left corner” and “width and height” of the section (Area of Interest) he is interested in to determine the size and thus the highest possible frame rate.

Setting the AOI is done in the IMAGE_POSITION and IMAGE_SIZE registers.
Attention should be paid to the increments entered in the UNIT_SIZE_INQ and UNIT_POSITION_INQ registers when configuring IMAGE_POSITION and IMAGE_SIZE.

IMAGE_POSITION and IMAGE_SIZE contain in the respective bits values for the column and line of the upper left corner and values for the width and height.

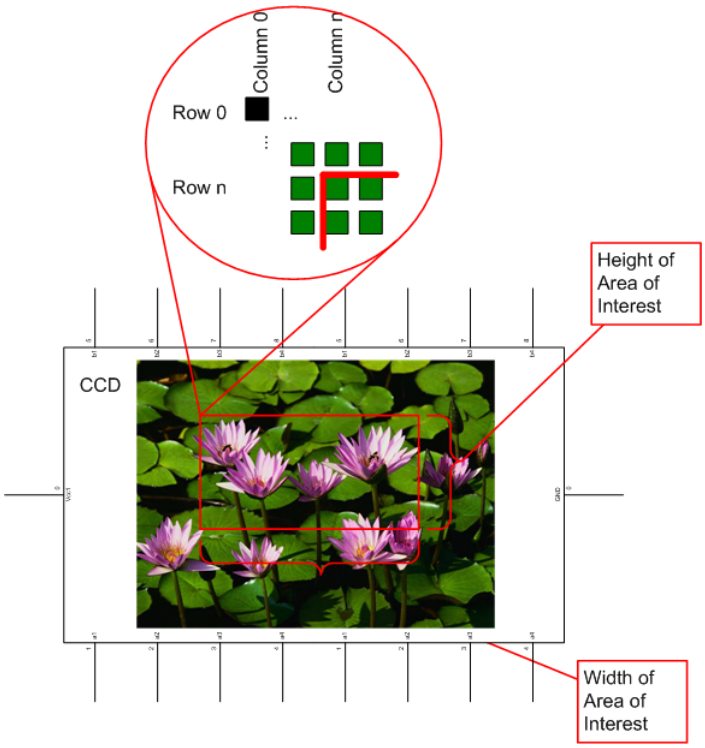


Figure 43: Area of Interest

ⓘ The left position + width and the upper position + height may not exceed the maximum resolution of the sensor.

ⓘ The coordinates for width and height must be divisible by 4.

In addition to the Area of Interest, some other parameters have an effect on the maximum frame rate:

- the time for reading the image from the sensor and transporting it into the FRAME_BUFFER
- the time for transferring the image over the FireWire™ bus
- the length of the exposure time.

10.7 Frame rates

An IEEE-1394 camera requires bandwidth to transport images.

The IEEE-1394a bus has very large bandwidth of at least 32 MB/s for transferring (isochronously) image data. Per cycle up to 4096 bytes (or around 1000 quadlets = 4 bytes) can thus be transmitted.
Depending on the video format settings and the configured frame rate, the camera requires a certain percentage of maximum available bandwidth. Clearly the bigger the image and the higher the frame rate, there is more data to be transmitted.
The following tables indicate the volume of data in various formats and modes to be sent within one cycle (125µs) at 400 Mb/s of bandwidth.
The tables are divided into three formats; F_0 up to VGA, F_1 up to XGA, and F_2 up to UXGA.
They enable you to calculate the required bandwidth and to ascertain the number of cameras that can be operated independently on a bus and in which mode.

Format	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps
0	0	160 x 120 YUV (4:4:4) 24 bit/pixel		1/2H 80p 60q	1/4H 40p 30q	1/8H 20p 15q	
	1	320 x 240 YUV (4:2:2) 16 bit/pixel		1H 320p 160q	1/2H 160p 80q	1/4H 80p 40q	1/8H 40p 20q
	2	640 x 480 YUV (4:1:1) 12 bit/pixel		2H 1280p 480q	1H 640p 240q	1/2H 320p 120q	1/4H 160p 60q
	3	640 x 480 YUV (4:2:2) 16 bit/pixel		2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	4	640 x 480 RGB 24 bit/pixel		2H 1280p 960q	1H 640p 480q	1/2H 320p 240q	1/4H 160p 120q
	5	640 x 480 (MONO8) 8 bit/pixel	4H 2560p 640q	2H 1280p 320q	1H 640p 160q	1/2H 320p 80q	1/4H 160p 40q
	6	640 x 480 Y (MONO16) 16 Bit/pixel		2H 1280p 640q	1H 640p 320q	1/2H 320p 160q	1/4H 160p 80q
	7	640 x 480 Y (MONO16) Reserved					

Table 39: Format_0

As an example, VGA MONO8 @ 60 fps requires four lines (640 x 4 = 2560 pixels/byte) to transmit every 125 µs: this is a consequence of the sensor's line time of about 30 µs, so that no data needs to be stored temporarily. It takes 120 cycles (120 x 125 µs = 15 ms) to transmit one frame, which arrives every 16.6 ms from the camera. Again no data need to be stored temporarily.
Thus around 64 % of the available bandwidth is used.

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
1	0	800 x 600 YUV (4:2:2) 16 bit/pixel		5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	6/16H 250p 125q	
	1	800 x 600 RGB 24 Bit/pixel			5/4H 1000p 750q	5/8H 500p 375q		
	2	800 x 600 Y (MONO8) 8 bit/pixel	5H 4000p 1000q	5/2H 2000p 500q	5/4H 1000p 250q	5/8H 500p 125q		
	3	1024 x 768 YUV (4:2:2) 16 bit/pixel			3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q
	4	1024 x 768 RGB 24 bit/pixel				3/4H 768p 576q	3/8H 384p 288q	3/16H 192p 144q
	5	1024 x 768 Y (MONO) 8 bit/pixel		3H 3072p 768q	3/2H 1536p 384q	3/4H 768p 192q	3/8H 384p 96q	3/16H 192p 48q
	6	800 x 600 (MONO16) 16 bit/pixel		5/2H 2000p 1000q	5/4H 1000p 500q	5/8H 500p 250q	5/16H 250p 125q	
	7	1024 x 768 Y (MONO16) 16 bit/pixel			3/2H 1536p 768q	3/4H 768p 384q	3/8H 384p 192q	3/16H 192p 96q

Table 40: Format_1

For-mat	Mode	Resolution	60 fps	30 fps	15 fps	7.5 fps	3.75 fps	1.875 fps
2	0	1280 x 960 YUV (4:2:2) 16 bit/pixel				1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	1	1280 x 960 RGB 24 bit/pixel				1H 1280p 960q	1/2H 640p 480q	1/4H 320p 240q
	2	1280 x 960 Y (MONO8) 8 bit/pixel			2H 2560p 640q	1H 1280p 320q	1/2H 640p 160q	1/4H 320p 80q
	3	1600 x 1200 YUV(4:2:2) 16 bit/pixel				5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q
	4	1600 x 1200 RGB 24 bit/pixel					5/8H 1000p 750q	5/16 500p 375q
	5	1600 x 1200 Y (MONO) 8 bit/pixel			5/2H 4000p 1000q	5/4H 2000p 500q	5/8H 1000p 250q	5/16H 500p 125q
	6	1280 x 960 Y (MONO16) 16 bit/pixel				1H 1280p 640q	1/2H 640p 320q	1/4H 320p 160q
	7	1600 x 1200Y(MONO16) 16 bit/pixel				5/4H 2000p 1000q	5/8H 1000p 500q	5/16H 500p 250q

Table 41: Format_2

As already mentioned, the recommended limit for transferring isochronous image data is 1000q (quadlets) per cycle or 4096 bytes (with 400 Mb/s of bandwidth).

The third table shows that a MF-145B2 @ 7.5 fps has to send 1280 pixels or 1 line of video per cycle. The camera thus uses 32 % of available bandwidth. This allows up to three cameras with these settings to be operated independently on the same bus.

ⓘ If the cameras are operated with an external trigger the maximum trigger frequency may not exceed the highest continuous frame rate, so preventing frames from being dropped or corrupted.

The frame rates in video modes 0 to 2 are specified and set fixed by IIDC V. 1.3.

In video Format_7 frame rates are no longer fixed but can be varied dynamically by the parameters described below.

The following formula is used to calculate for the CCD models the highest frame rate in Format_7:

$$FPS_{In} = FPS_{CCD} = \frac{1}{T_{Charge Trans} + T_{Dummy} + T_{Dump} + T_{Scan}}$$

Formula 1: Frame rate calculation

It assumes that the maximum frame rate is the inverse of the sum of all events in a CCD, which take time such as:

- The time to transfer the storage to the vertical shift register (Charge transfer time)
- The time to shift out the dummy lines
- The time to dump the lines outside the AOI
- The time to shift out the lines of the AOI. (Scanning time)

For the different sensors, different values apply.

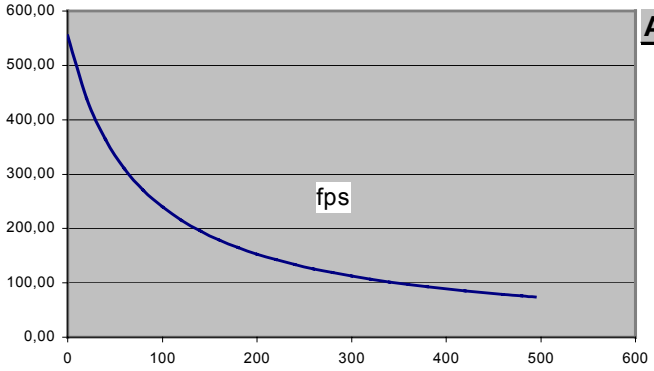
10.7.1 MF-033

Different parameters apply for the different models.

$$fps = \frac{1}{T_{Charge Trans} + T_{Dummy} + T_{Dump} + T_{Scan}}$$

$$fps = \frac{1}{30\mu s + 68.5\mu s + (494 - AOI\_HEIGHT) \cdot 3.45\mu s + AOI\_HEIGHT \cdot 27.1\mu s}$$

Formula 2: Frame rate calculation MF-033



AOI_HEIGHT	fps	Tf/ms
494	74,15	13,49
480	76,02	13,15
400	88,79	11,26
320	106,71	9,37
240	133,71	7,48
120	215,48	4,64
20	439,41	2,28

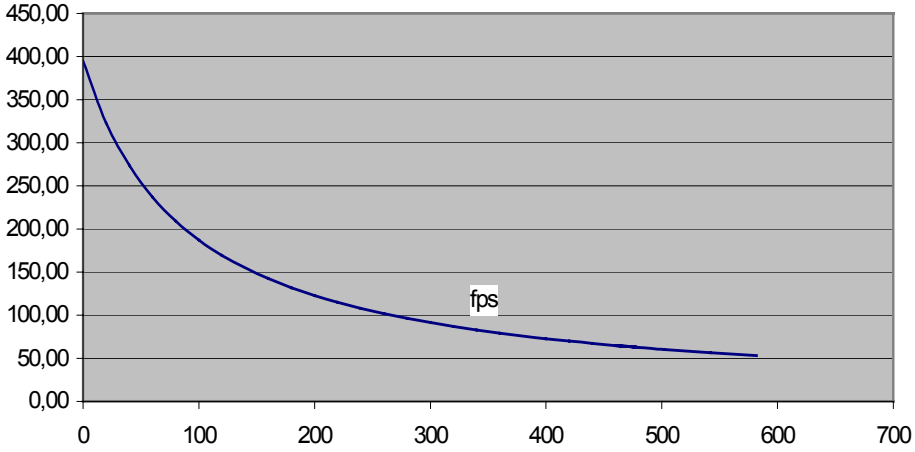
Table 42: Frame rates MF-033

10.7.2 MF-046

$$fps = \frac{1}{T_{Charge Trans} + T_{Dummy} + T_{Dump} + T_{Scan}}$$

$$fps = \frac{1}{31\mu s + 88\mu s + (582 - AOI\_HEIGHT) \cdot 4.15\mu s + AOI\_HEIGHT \cdot 32.2\mu s}$$

Formula 3: Frame rate calculation MF-046



AOI_HEIGHT	fps	Tf/ms
582	53,02	18,86
480	62,51	16,00
400	72,70	13,75
320	86,88	11,51
300	91,33	10,95
240	107,92	9,27
120	169,48	5,90
20	323,07	3,10

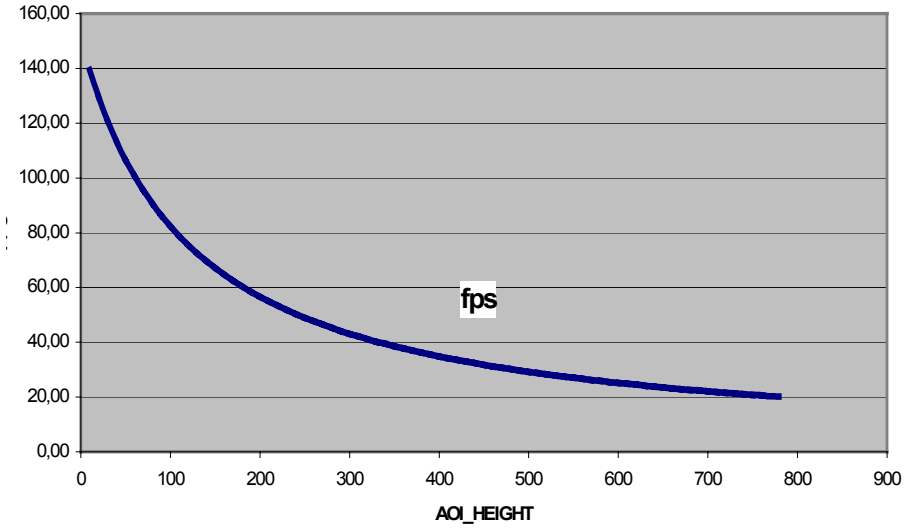
Table 43: Frame rates MF-046

10.7.3 MF-080

$$fps = \frac{1}{T_{Charge Trans} + T_{Dummy} + T_{Dump} + T_{Scan}}$$

$$fps = \frac{1}{71.93\mu s + 129.48\mu s + (779 - AOI\_HEIGHT) \cdot 8.24\mu s + AOI\_HEIGHT \cdot 63.48\mu s}$$

Formula 4: Frame rate calculation MF-080



AOI_HEIGHT	fps	Tf/ms
778	20,16	49,60
770	20,34	49,16
768	**20,39**	49,04
760	20,57	48,60
500	29,21	34,24
490	29,68	33,69
480	**30,18**	33,14
470	30,69	32,58
460	31,22	32,03
450	31,77	31,48
240	**50,31**	19,88
120	75,48	13,25
110	78,76	12,70
100	82,34	12,14
90	86,27	11,59
80	90,58	11,04

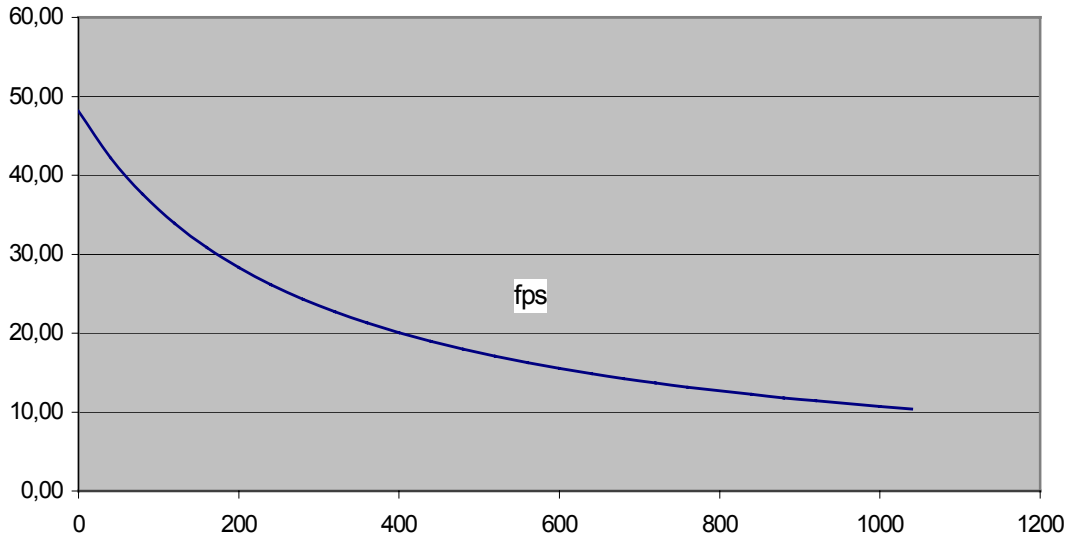
Table 44: Frame rates MF-080

10.7.4 MF-145B2

$$fps = \frac{1}{T_{Charge Trans} + T_{Dummy} + T_{Dump} + T_{Scan}}$$

$$fps = \frac{1}{105\mu s + 288\mu s + (1040 - AOI\_HEIGHT) \cdot 19.6\mu s + AOI\_HEIGHT \cdot 92.3\mu s}$$

Formula 5: Frame rate calculation MF-145



AOI_HEIGHT	fps	Tf/ms
1040	10,38	96,39
960	11,04	90,57
600	15,53	64,40
480	17,96	55,67
240	26,16	38,23
120	33,90	29,50
60	39,78	25,14

Table 45: Frame rates MF-145

10.7.5 MF-131

This model uses a CMOS sensor with global as well as rolling shutter. As mentioned earlier for the most useful global shutter, the integration time must be added to the readout time to define the maximum frame rate. The next table gives an example: (it assues an integration time of 1 ms)

AOI_HEIGHT	fps
1024	24,42
960	26,01
600	40,97
480	50,69
240	96,46
120	175,84
60	298,78
format7, global-shutter	
1ms integration-time	

Table 46: Frame rates MF-131

10.8 How does bandwidth affect the frame rate?

In some modes the IEEE-1394a bus limits the attainable frame rate. According to the 1394a specification on isochronous transfer, the largest data payload size of 4096 bytes per 125 µs cycle is possible with bandwidth of 400 Mb/s. In addition, because of a limitation in an IEEE-1394 module (GP2Lynx), only a maximum number of 4095 packets per frame are allowed.

The following formula establishes the relationship between the required Byte_Per_Packet size and certain variables for the image. It is valid only for Format_7.

$$BYTE\_PER\_PACKET = fps * AoiWidth * AoiHeight * ByteDepth * 125\mu s$$

Formula 6: Byte_per_Packet calculation

If the value for "BYTE_PER_PACKET" is greater than 4096 (the maximum data payload), the sought-after frame rate cannot be attained. The attainable frame rate can be calculated using this formula:

(Provision: "BYTE_PER_PACKET" is divisible by 4):

$$fps \approx \frac{BYTE\_PER\_PACKET}{AoiWidth \cdot AoiHeight \cdot ByteDepth \cdot 125\ \mu s}$$

Formula 7: Max. fps Calculation

ByteDepth based on the following values:

Mono8	=> 8 bits/pixel	= 1	byte per pixel
Mono16	=> 16 bits/pixel	= 2	bytes per pixel
YUV4:2:2	=> 16 bits/pixel	= 2	bytes per pixel
YUV4:1:1	=> 12 bits/pixel	= 1.5	bytes per pixel

Example formula for the b/w camera:

Mono16, 1392 x 1040 – 15 fps desired

$$BYTE\_PER\_PACKET = 15 \cdot 1392 \cdot 1040 \cdot 2 \cdot 125\mu s = 5428 > 4096$$

$$\Rightarrow fps_{reachable} \approx \frac{4096}{1392 \cdot 1040 \cdot 2 \cdot 125\mu s} = 11{,}32$$

Formula 8: Example max. fps calculation

10.9 Test images

The b/w cameras have two test images that look the same. Both images show a gray bar running diagonally. One test image is static, the other moves upwards by 1 pixel/frame.

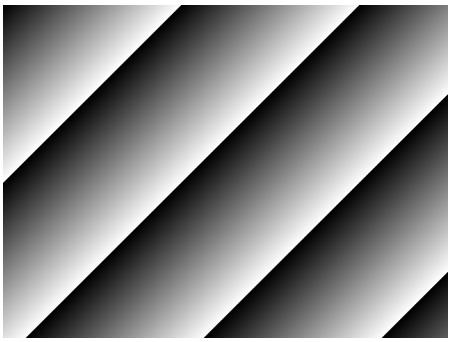


Figure 44: Gray bar test image

Formula for calculating the gray value:

Gray value = (x+y) MOD256 (8-bit mode)

The color cameras have the following test image :

YUV4:2:2 mode

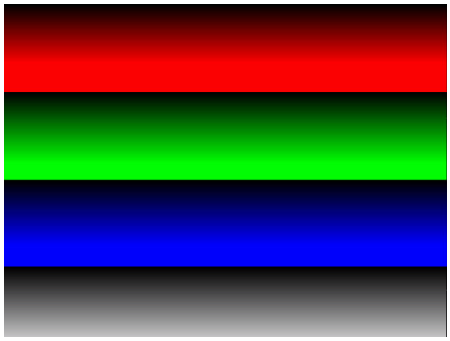


Figure 45: Color test image

Mono8 (raw data):

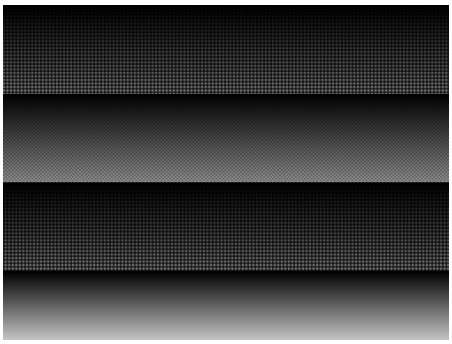


Figure 46: Bayer-coded test image

The color camera outputs Bayer-coded raw data in Mono8 instead of – as described in IIDC v. 1.3 – a real Y signal. The first pixel of the image is always the red pixel from the sensor.

11 Configuration of the camera

All camera settings are made by writing specific values into the corresponding registers. This applies to both values for general operating states such as video formats and modes, exposure times, etc. and to all extended features of the camera that are turned on and off and controlled via corresponding registers.

11.1 Camera_Status_Register

The interoperability of cameras from different manufacturers is ensured by IIDC, formerly DCAM (Digital Camera Specification), published by the IEEE-1394 Trade Association.
IIDC is primarily concerned with setting memory addresses (e.g. CSR: Camera_Status_Register) and their meaning.

In principle all addresses in IEEE-1394 networks are 64 bits long.

The first 10 bits describe the Bus_Id, the next 6 bits the Node_Id.
Of the subsequent 48 bits, the first 16 are is always FFFFh, leaving the description for the Camera_Status_Register in the last 32 bits.

If in the following, mention is made of a CSR F0F00600h, this means in full:

Bus_Id, Node_Id, FFFF F0F00600h

Writing and reading to and from the register can be done with programs such as “FireView” or by other programs that are developed using an API library(e.g. FirePackage).

Every register is 32 bit (Big Endian) and implemented as follows:

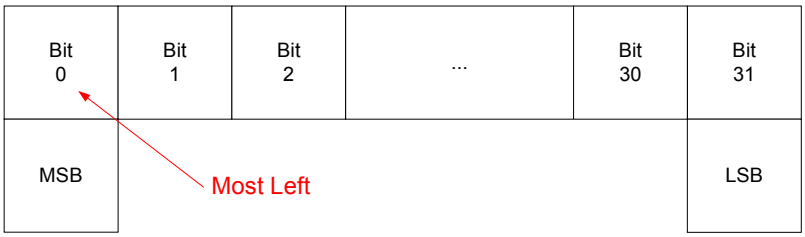


Figure 47: 32-bit register

This requires, for example, that to enable *ISO_Enabled* mode (ISO_Enable / Free-Run), (bit 0 in register 614h), the value 80000000 h must be written in the corresponding register.

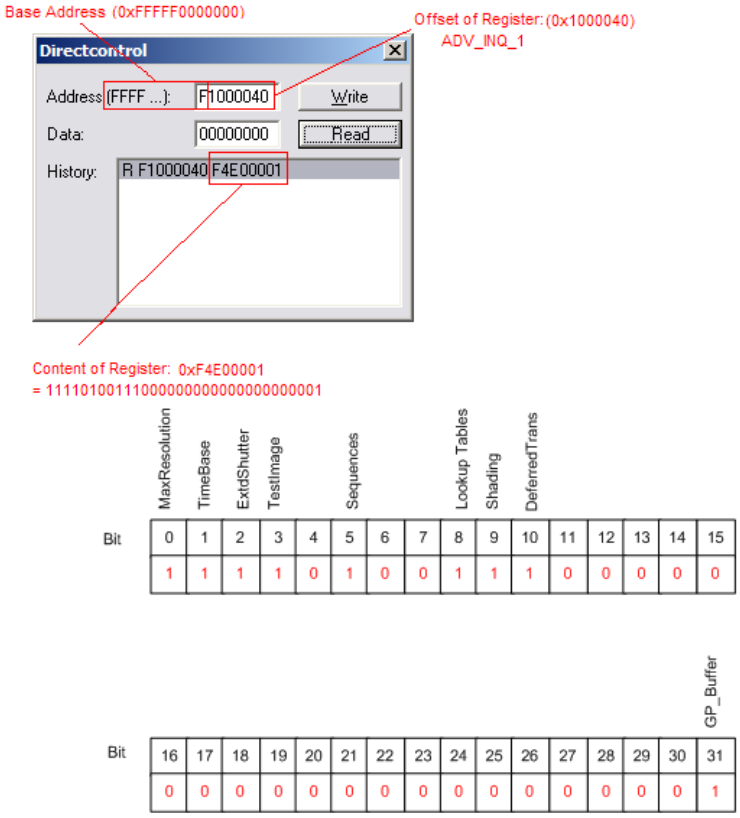


Figure 48: Configuration of the camera

Sample program:

The following sample code in C shows how the register is set for frame rate, video mode/format and trigger mode using the FireCtrl DLL from the FirePackage API. Also shown is how the camera is switched into ISO_Enabled mode:

```
...
WriteQuad(m_cmdRegBase + CCR_FRAME-RATE, Frame-Rate << 29);
WriteQuad(m_cmdRegBase + CCR_VMODE, mode << 29);
WriteQuad(m_cmdRegBase + CCR_VFORMAT, format << 29);
WriteQuad(m_cmdRegBase + CCR_TRGMODE, extTrigger ? 0x82000000 : 0);
Sleep(100);
WriteQuad(m_cmdRegBase + CCR_ISOENABLE, 0x80000000);
...
```

11.2 Configuration ROM

The information in the Configuration ROM is needed to identify the node, its capabilities and which drivers are required.

The base address for the "configuration ROM" for all registers is FFFF F0000000h.
The ConfigRom is divided into the

- Bus info block: providing critical information about the bus-related capabilities,
- Root directory: specifying the rest of the content and organization, such as:
  - Node unique ID leaf
  - Unit directory and
  - Unit dependant info

The base address of the camera control register is calculated as follows based on the camera-specific base address:

	Offset	0-7	8-15	16-23	24-31
Bus info block	400h	04	24	45	EE
	404h	31	33	39	34
	408h	20	00	A0	00
	40Ch	00	0A	47	01
	410h	00	00	Serial number	
Root directory	414h	00	04	B7	85
	418h	03	00	0A	47
	41Ch	0C	00	83	C0
	420h	8D	00	00	02
	424h	D1	00	00	04

.... ASCII for 1394

.... Bus capabilities

.... Node_Vendor_Id, Chip_id_hi

.... Chip_id_lo

According to IEEE1212, the root directory may have another length. The keys (e.g. 8D) point to the offset factors rather than the offset (e.g.420h) itself.

Table 47: Config Rom

The entry with key 8D in the root directory (420h in this case) provides the offset for the unique ID leaf node as follows: 420h + 000002 * 4 = 428h

	Offset	0-7	8-15	16-23	24-31
Node unique ID leaf	428h	00	02	CA	71
	42Ch	00	0A	47	01
	430h	00	00	Serial number	

The entry with key D1 in the root directory (424h in this case) provides the offset for the unit directory as follows: 424h + 000004 * 4 = 434h

	Offset	0-7	8-15	16-23	24-31
Unit directory	434h	00	03	93	7D
	438h	12	00	A0	2D
	43Ch	13	00	01	02
	440h	D4	00	00	01

The entry with key D4 in the unit directory (440h in this case) provides the offset for unit dependent info: 440h + 000001 * 4 = 444h

	Offset	0-7	8-15	16-23	24-31
	444h	00	03	7F	89

Unit dependent info	448h	40	3C	00	00
	44Ch	81	00	00	02
	450h	82	00	00	06

Table 48: ConfigRom cont.

And finally, the entry with key 40 (448h in this case) provides the offset for the camera control register:

FFFF F0000000h + 3C0000h * 4 = FFFF F0F00000h

The base address of the camera control register is thus
FFFF F0F00000h.

The offset entered in the table always refers to the base address of F0F00000h.

ⓘ This means that if you want to use the "DirectControl" program to read or write to a register, the following value must be entered in the *Address* field:

"F0F00000h + Offset"

11.3 Implemented registers

The following tables show how standard registers from IIDC v. 1.3 are implemented in the camera. Differences and explanations can be found in the third column.

11.3.1 Camera initialize register

Offset	Name	Notes
000h	INITIALIZE	

Table 49: Camera initialize register

11.3.2 Inquiry register for video format

Offset	Name	Notes
100h	V_FORMAT_INQ	

Table 50: Format inquiry register

11.3.3 Inquiry register for video mode

Offset	Name	Notes
180h	V_MODE_INQ_0 (Format_0)	
184h	V_MODE_INQ_1 (Format _1)	
188h	V_MODE_INQ_2 (Format_2)	
18Ch ... 197h	Reserved for other V_MODE_INQ_x for Format_x.	always 0
198h	V_MODE_INQ_6 (Format_6)	always 0
19Ch	V_MODE_INQ_7 (Format_7)	

Table 51: Video mode inquiry register

11.3.4 Inquiry register for video frame rate and base address

Offset	Name	Notes
200h	V_RATE_INQ_0_0 (Format_0, Mode_0)	
204h	V_RATE_INQ_0_1 (Format_0, Mode_1)	
208h	V_RATE_INQ_0_2 (Format_0, Mode_2)	
20Ch	V_RATE_INQ_0_3 (Format_0, Mode_3)	
210h	V_RATE_INQ_0_4 (Format_0, Mode_4)	
214h	V_RATE_INQ_0_5 (Format_0, Mode_5)	
218h	V_RATE_INQ_0_6 (Format_0, Mode_6)	
21Ch ... 21Fh	Reserved V_RATE_INQ_0_x (for other Mode_x of Format_0)	always 0
220h	V_RATE_INQ_1_0 (Format_1, Mode_0)	
224h	V_RATE_INQ_1_1 (Format_1, Mode_1)	
228h	V_RATE_INQ_1_2 (Format_1, Mode_2)	
22Ch	V_RATE_INQ_1_3 (Format_1, Mode_3)	
230h	V_RATE_INQ_1_4 (Format_1, Mode_4)	
234h	V_RATE_INQ_1_5 (Format_1, Mode_5)	
238h	V_RATE_INQ_1_6 (Format_1, Mode_6)	
23Ch	V_RATE_INQ_1_7 (Format_1, Mode_7)	
240h	V_RATE_INQ_2_0 (Format_2, Mode_0)	
244h	V_RATE_INQ_2_1 (Format_2, Mode_1)	
248h	V_RATE_INQ_2_2 (Format_2, Mode_2)	
24Ch	V_RATE_INQ_2_3 (Format_2, Mode_3)	
250h	V_RATE_INQ_2_4 (Format_2, Mode_4)	
254h	V_RATE_INQ_2_5 (Format_2, Mode_5)	
258h	V_RATE_INQ_2_6 (Format_2, Mode_6)	
25Ch	V_RATE_INQ_2_7 (Format_2, Mode_7)	
260h ... 2BFh	Reserved V_RATE_INQ_y_x (for other Format_y, Mode_x)	
2C0h	V_REV_INQ_6_0 (Format_6, Mode0)	always 0
2C4h .. 2DFh	Reserved V_REV_INQ_6_x (for other Mode_x of Format_6)	always 0
2E0h	V-CSR_INQ_7_0	
2E4h	V-CSR_INQ_7_1	
2E8h	V-CSR_INQ_7_2	
2Ech	V-CSR_INQ_7_3	
2F0h	V-CSR_INQ_7_4	
2F4h	V-CSR_INQ_7_5	
2F8h	V-CSR_INQ_7_6	
2FCh	V-CSR_INQ_7_7	

Table 52: Frame rate inquiry register

11.3.5 Inquiry register for basic function

Offset	Name	Notes
400h	BASIC_FUNC_INQ	

Table 53: Basic function inquiry register

11.3.6 Inquiry register for feature presence

Offset	Name	Notes
404h	Feature_Hi_Inq	
408h	Feature_Lo_Inq	
40Ch .. 47Fh	Reserved	Address error on access
480h	Advanced_Feature_Inq	This register is the offset for the Access_Control_Register and thus the base address for Advanced Features. Access_Control_Register does not prevent access to advanced features. In some programs it should still always be activated first. “Advanced Feature Set Unique Value” is 7ACh and CompanyID is A47h.

Table 54: Feature presence inquiry register

11.3.7 Inquiry register for feature elements

Offset	Name	Notes
500h	BRIGHTNESS_INQ	
504h	AUTO_EXPOSURE_INQ	always 0
508h	SHARPNESS_INQ	always 0
50Ch	WHITE_BAL_INQ	Mono: always 0
510h	HUE_INQ	always 0
514h	SATURATION_INQ	always 0
518h	GAMMA_INQ	
51Ch	SHUTTER_INQ	
520h	GAIN_INQ	
524h	IRIS_INQ	always 0
528h	FOCUS_INQ	always 0
52Ch	TEMPERATURE_INQ	
530h	TRIGGER_INQ	
534 .. 57Ch	Reserved for other FEATURE_HI_INQ	always 0
580h	ZOOM_INQ	always 0
584h	PAN_INQ	always 0
588h	TILT_INQ	always 0
58Ch	OPTICAL_FILTER_INQ	always 0
590 .. 5BCh		always 0
5C0h	CAPTURE_SIZE_INQ	always 0
5C4h	CAPTURE_QUALITY_INQ	always 0
5C8h .. 5FCh	Reserved for other FEATURE_LO_INQ	always 0
600h	CUR-V-Frm_RATE/Revision	See above
604h	CUR-V-MODE	See above
608h	CUR-V-FORMAT	See above
60Ch	ISO-Channel	
610h	Camera_Power	always 0
614h	ISO_EN/Continuous_Shot	
618h	Memory_Save	always 0
61Ch	One_Shot Multi_Shot Count Number	
620h	Mem_Save_Ch	always 0
624	Cur_Mem_Ch	always 0
628h	Vmode_Error_Status	See above

Table 55: Feature elements inquiry register

11.3.8 Inquiry register for absolute value CSR offset address

Offset	Name	Notes
700h	ABS_CSR_HI_INQ_0	always 0
704h	ABS_CSR_HI_INQ_1	always 0
708h	ABS_CSR_HI_INQ_2	always 0
70Ch	ABS_CSR_HI_INQ_3	always 0
710h	ABS_CSR_HI_INQ_4	always 0
714h	ABS_CSR_HI_INQ_5	always 0
718h	ABS_CSR_HI_INQ_6	always 0
71Ch	ABS_CSR_HI_INQ_7	always 0
720h	ABS_CSR_HI_INQ_8	always 0
724h	ABS_CSR_HI_INQ_9	always 0
728h	ABS_CSR_HI_INQ_10	always 0
72Ch	ABS_CSR_HI_INQ_11	always 0
730h	ABS_CSR_HI_INQ_12	always 0
734 .. 77Fh	Reserved	always 0
780h	ABS_CSR_LO_INQ_0	always 0
784h	ABS_CSR_LO_INQ_1	always 0
788h	ABS_CSR_LO_INQ_2	always 0
78Ch	ABS_CSR_LO_INQ_3	always 0
790h .. 7BFh	Reserved	always 0
7C0h	ABS_CSR_LO_INQ_16	always 0
7C4h	ABS_CSR_LO_INQ_17	always 0
7C8h .. 7FFh	Reserved	always 0

Table 56: Absolute value inquiry register

11.3.9 Status and control register for feature

The *OnePush* feature, WHITE_BALANCE, is currently implemented. If this flag is set, the feature becomes immediately active, even if no images are being input (see Automatic white balance).

Offset	Name	Notes
800h	BRIGHTNESS	
804h	AUTO-EXPOSURE	always 0
808h	SHARPNESS	always 0
80Ch	WHITE-BALANCE	See above always 0 for Mono
880h	HUE	always 0
814h	SATURATION	always 0
818h	GAMMA	
81Ch	SHUTTER	see Advanced Feature Timebase
820h	GAIN	
824h	IRIS	always 0
828h	FOCUS	always 0
82Ch	TEMPERATURE	always 0
830h	TRIGGER-MODE	Can be effected via Advanced Feature IO_INP_CTRLx.
834h .. 87C	Reserved for other FEATURE_HI	always 0
880h	Zoom	always 0
884h	PAN	always 0
888h	TILT	always 0
88Ch	OPTICAL_FILTER	always 0
890 .. 8BCh	Reserved for other FEATURE_LO	always 0
8C0h	CAPTURE-SIZE	always 0
8C4h	CAPTURE-QUALITY	always 0
8C8h .. 8FCh	Reserved for other FEATURE_LO	always 0

Table 57: Feature control register

11.3.10 Feature control error status register

Offset	Name	Notes
640h	Feature_Control_Error_Status_HI	always 0
644h	Feature_Control_Error_Status_LO	always 0

Table 58: Feature control error register

11.3.11 Video mode control and status registers for Format_7

The offset to the base address is in V_CSR_INQ_7_x. The offset 100h must be added for *Mode 1*, 200h for *Mode 2* 200h and 300h for *Mode 3*.

Offset	Name	Notes
000h	MAX_IMAGE_SIZE_INQ	
004h	UNIT_SIZE_INQ	
008h	IMAGE_POSITION	
00Ch	IMAGE_SIZE	See above
010h	COLOR_CODING_ID	See above
014h	COLOR_CODING_INQ	See above
034h	PIXEL_NUMER_INQ	
038h	TOTAL_BYTES_HI_INQ	
03Ch	TOTAL_BYTES_LO_INQ	
040h	PACKET_PARA_INQ	See above
044h	BYTE_PER_PACKET	See above

Table 59: Format_7 control and status register

ⓘ For all modes in Format_7, *ErrorFlag_1* and *ErrorFlag_2* are refreshed on each access to the Format_7 Register.

ⓘ Contrary to IIDC DCAM v. 1.3, registers relevant to Format_7 are refreshed on each access. The “Setting_1” bit is automatically cleared after each access.

ⓘ When *ErrorFlag_1* or *ErrorFlag_2* is set and Format_7 is configured, no image capture is started.

ⓘ Contrary to IIDC v.1.3, COLOR_CODING_ID is set to a default value after an INITIALIZE or “reset”.

ⓘ Contrary to IIDC DCAM v.1.3, the *UnitBytePerPacket* field is already filled in with a fixed value in the PACKET_PARA_INQ register.

11.4 Advanced features

The camera has a variety of extended features going beyond the possibilities described in IIDC v. 1.3. The following chapter summarizes all available advanced features in ascending register order.

Advanced features should always be activated before accessing them.

The color and B/W models of the camera vary in their availability in some of the advanced features.

ⓘ Currently all registers can be written without being activated. This makes it easier to operate the camera using "Directcontrol".

ⓘ AVT reserves the right to require activation in future versions of the software.

11.4.1 Version information inquiry

The presence of each of the following features can be queried by the "0" bit of the corresponding register.

Offset	Name	Field	Bit	Description
0xF1000010	VERSION_INFO1	µC type ID	[0..15]	Always 0
		µC version	[16..31]	Bcd-coded vers.#
0xF1000014			[0..31]	reserved
0xF1000018	VERSION_INFO3	FPGA type ID	[0..15]	See below
			[16..31]	Bcd-coded vers.#
0xF100001C			[0..31]	reserved

Table 60: Version information register

This register holds information about the node_hw_version, the node_sw_version and the node_spec_ID (camera type). µC version and FPGA version are bcd-coded, which means that e.g. firmware version 0.85 is read as 0x0085. The FPGA type ID identifies the camera type with the help of the following list:

ID	Camera type		ID	Camera type
1	DF-145B		10	MF-033C
2	DF-145C		11	MF-046B
3	DF-201B		12	MF-046C
4	DF-201C		13	MF-080B
5	DF-145B-1		14	MF-080C
6	DF-145C-1		15	MF-131B
7	DF-201B-1		16	MF-131C
8	DF-201C-1		17	MF-145B2
9	MF-033B		18	MF-145C2

Table 61: Camera type ID list

11.4.2 Advanced feature inquiry

Offset	Name	Field	Bit	Description
0xF1000040	ADV_INQ_1	MaxResolution	[0]	
		TimeBase	[1]	
		ExtdShutter	[2]	
		TestImage	[3]	
		---	[4]	
		Sequences	[5]	
		--	[6..7]	
		Lookup Tables	[8]	
		Shading	[9]	
		DeferredTrans	[10]	
		HDR mode	[11]	MF-131B/C only
		---	[12..30]	
		GP_Buffer	[31]	
0xF1000044	ADV_INQ_2	Input_1	[0]	
		Input_2	[1]	
		Input_3	[2]	
		---	[3..7]	
		Output_1	[8]	
		Output_2	[9]	
		Output_3	[10]	
		---	[11..15]	
		IntEnaDelay	[16]	
		IncDecoder	[17]	
		---	[18..31]	
0xF1000048	ADV_INQ_3	---	[0..31]	
0xF100004C	ADV_INQ_4	---	[0..31]	

Table 62: Advanced feature inquiry register

11.4.3 MaxResolution

This register indicates the highest resolution for the sensor and is read-only.
This register normally outputs the MAX_IMAGE_SIZE_INQ Format_7 Mode_0 value.

Offset	Name	Field	Bit	Description
0xF1000200	MAX_RESOLUTION	MaxHeight	[0..15]	Sensor height (rd only)
		MaxWidth	[16..31]	Sensor width (rd only)

Table 63: Max. resolution inquiry register

11.4.4 Timebase

Corresponding to IIDC, exposure time is set via a 12-bit value in the corresponding register (SHUTTER_INQ [51Ch] and SHUTTER [81Ch]).
This means that a value in the range of 1 to 4095 can be entered.

Marlin cameras use a time-base which is multiplied by the shutter register value. This multiplier is configured as the time base via the TIMEBASE register.

Offset	Name	Field	Bit	Description
0xF1000208	TIMEBASE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..27]	
		Timebase_ID	[28..31]	

Table 64: Timebase configuration register

IDs 0-9 are in bits 28 to 31. Refer to the following table for code. Default time-base is 20µs.

This means that the integration time can be changed in 20 µs increments with the shutter control.
Time-base can only be changed when the camera is in idle state and becomes active only after setting the shutter value.

ID	Timebase			ID	Timebase	
0	1	µs		5	50	µs
1	2	µs		6	100	µs
2	5	µs		7	200	µs
3	10	µs		8	500	µs
4	20	µs		9	1000	µs

Table 65: Timbease ID

ⓘ The ABSOLUTE VALUE CSR register, introduced in IIDC v. 1.3, is not implemented.

11.4.5 Extended shutter

The exposure time for long-term integration of up to 67 sec can be entered with µs- precision via the EXTENDED_SHUTTER register.

Offset	Name	Field	Bit	Description
0xF100020C	EXTD_SHUTTER	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1.. 5]	
		ExpTime	[6..31]	Exposure time in µs

Table 66: Extended shutter configuration register

The longest exposure time, 3FFFFFFh, corresponds to 67.11 sec.

- ⓘ Exposure times entered via the 81Ch register are mirrored in the extended register, but not vice versa.
- ⓘ Changes in this register have immediate effect, even when camera is transmitting.
- ⓘ Extended shutter becomes inactive after writing to a format/mode/framerate register.
- ⓘ Extended shutter setting will thus be overwritten by the normal timebase/shutter setting after Stop/Start of FireView or FireDemo.

11.4.6 Test images

Bits 8-14 indicate which test images are saved. Setting bits “28-31” activates or deactivates existing test images.

Offset	Name	Field	Bit	Description
0xF1000210	TEST_IMAGE	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7	
		Image_Inq_1	[8]	Presence of test image 1 0: N/A 1: Available
		Image_Inq_2	[9]	Presence of test image 2 0: N/A 1: Available
		Image_Inq_3	[10]	Presence of test image 3 0: N/A 1: Available
		Image_Inq_4	[11]	Presence of test image 4 0: N/A 1: Available
		Image_Inq_5	[12]	Presence of test image 5 0: N/A 1: Available
		Image_Inq_6	[13]	Presence of test image 6 0: N/A 1: Available
		Image_Inq_7	[14]	Presence of test image 7 0: N/A 1: Available
		---	[15..27]	
		TestImage_ID	[28..31]	0: No test image active 1: Image 1 active 2: Image 2 active …

Table 67: Test image configuration register

11.4.7 Sequence control

It is possible to make certain settings for a sequence of images beforehand by using this register.

Offset	Name	Field	Bit	Description
0xF1000220	SEQUENCE_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		AutoRewind	[5]	
		ON_OFF	[6]	Enable/Disable this feature
		---	[7..15]	
		MaxLength	[16..23]	Max. possible length of a sequence (read only)
		SeqLength	[24..31]	Length of the sequence
0xF1000224	SEQUENCE_PARAM	---	[0..4]	
		ApplyParameters	[5]	Apply settings to selected image of sequence; auto-reset
		IncImageNo	[6]	Increment ImageNo after ApplyParameters has finished
		---	[7..23]	
		ImageNo	[24..31]	Number of image within a sequence

Table 68: Sequence control register

11.4.8 Lookup tables (LUT) (FW > 0.90)

The LUT_CTRL register activates this feature and enables certain LUTs. The LUT_INFO register indicates how many LUTs the camera can store and the maximum size of the individual LUTs.

Offset	Name	Field	Bit	Description
0xF1000240	LUT_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	-
		ON_OFF	[6]	Enable/Disable this feature
		---	[7..25]	-
		LutNo	[26..31]	Use lookup table with number LutNo
0xF1000244	LUT_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		EnableMemWR	[5]	Enable write access
		---	[6..7]	
		AccessLutNo	[8..15]	
		AddrOffset	[16..31]	
0xF1000248	LUT_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	
		NumOfLuts	[8..15]	Max. # of lookup tables
		MaxLutSize	[16..31]	Max. lookup table size

Table 69: LUT control register

11.4.9 Shading correction

Owing to technical circumstances, the interaction of recorded objects with one another, optical effects and lighting non-homogeneities may occur in the images.

Because these effects are normally not desired, they should be eliminated as far as possible in subsequent image editing. The camera has automatic shading correction to do this.

Provided that a shading image is present in the camera, the *on/off* bit can be used to enable shading correction.

The “on/off” and “ShowImage” bits must be set for saved shading images to be displayed.

ⓘ Always make sure that the shading image is saved at the highest resolution of the camera. If a lower resolution is chosen and *ShowImage* is set to “true”, the image will not be displayed correctly.

Offset	Name	Field	Bit	Description
0xF1000250	SHDG_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		BuildError	[1]	tbd
		---	[2..3]	
		ShowImage	[4]	Show shading data as image
		BuildImage	[5]	Build a new ShadingImage
		ON_OFF	[6]	Shading On/Off
		Busy	[7]	Build in progress
		---	[8..23]	
		GrabCount	[24..31]	Number of images
0xF1000254	SHDG_MEM_CTRL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		EnableMemWR	[5]	Enable write access
		EnableMemRD	[6]	Enable read access
		---	[7]	
		AddrOffset	[8..31]	
0xF1000258	SHDG_INFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..7]	
		MaxImageSize	[8..31]	Max ShadingImage size

Table 70: Shading control register

11.4.10 Deferred image transport

Using the register, the sequence of recording and the transfer of the images can be paused. Setting “HoldImg” prevents transfer of the image. The images are stored in *ImageFIFO*.

The images indicated by *NumOfImages* are sent by setting the “SendImage” bit.

When “FastCapture” is set (in Format_7 only), images are recorded at the highest possible frame rate.

Offset	Name	Field	Bit	Description
0xF1000260	DEFERRED_TRANS	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..4]	
		SendImage	[5]	Send NumOfImages now (auto reset)
		HoldImg	[6]	Enable/Disable deferred transport mode
		FastCapture	[7]	Enable/disable fast capture mode
		---	[8..15]	
		FiFoSize	[16..23]	Size of FiFo in number of images (read only)
		NumOfImages	[24..31]	W: Number of images to send R: Number of images in buffer

Table 71: Deferred image configuration register

11.4.11 Frame information

This register can be used to double check the number of images received by the host computer against the number of images which were transmitted by the camera. The camera increments this counter with every FrameValid signal.

Offset	Name	Field	Bit	Description
0xF1000270	FRAMEINFO	Presence_Inq	[0]	Indicates presence of this feature (read only)
		ResetFrameCnt	[1]	Reset frame counter
		---	[2..31]	
0xF1000274	FRAMECOUNTER	FrameCounter	[0..31]	Number of captured frames since last reset

Table 72: Frame information register

11.4.12 High dynamic range mode (MF-131B/C only)

The CMOS sensor of the MF-131 offers a special mode by which various nonlinearity points, the so-called knee-points, can be freely adjusted. This enables the high dynamic range of the sensor to be compressed into 8 Bit, preserving interesting details of the image. This mode is also known as multiple slope (dual slope).

Offset	Name	Field	Bit	Description
0xF1000280	HDR_CONTROL	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	
		ON_OFF	[6]	Enable/disable HDR mode
		---	[7..19]	
		MaxKneePoints	[20…23]	Number of knee-points possible in this mode
		---	[24..27]	
		KneePoints	[28..31]	Number of active knee-points
0xF1000284	KNEEPOINT_1	---	[0..15]	
0xF1000284		Kneepoint1	[16..31]	Time in µs
0xF1000288	KNEEPOINT_2	---	[0..15]	
0xF1000288		Kneepoint2	[16..31]	Time in µs
0xF100028C	KNEEPOINT_3	---	[0..15]	
0xF100028C		Kneepoint3	[16..31]	Time in µs

Table 73: High dynamic range configuration register

11.4.13 Input/output pin control

All input and output signals running over the HiRose plug are controlled by this register.

Offset	Name	Field	Bit	Description
0xF1000300	IO_INP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	
		Polarity	[7]	0: low active, 1: high active
		---	[8..10]	
		InputMode	[11..15]	Mode
		---	[16..30]	
		PinState	[31]	RD: Current state of pin
0xF1000304	IO_INP_CTRL2	Same as IO_INP_CTRL1		

Table 74: Input control configuration register

IO_INP_CTRL 1-2

The *Polarity* flag determines whether the input is low active (0) or high active (1). The *input mode* can be seen in the following table. The *PinState* flag is used to query the current status of the input.

For inputs, the *PinState* bit refers to the inverted output side of the optical coupler. This means that an open input sets the *PinState* bit to "1".

ID	Mode	Default
0x00	Off	
0x01	reserved	
0x02	Trigger input	Input 1
0x03	Incremental decoder input	
0x04	reserved	
0x05	tbd (SPI external DCLK)	
0x06..0x0F	reserved	
0x10..0x1F	reserved	

Table 75: Input routing

Trigger

If more than one input is being operated in *trigger mode*, these inputs are logically linked by AND.

IO_OUTP_CTRL 1-2

The *Polarity* flag determines whether the output is low active (0) or high active (1). The *output mode* can be seen in the following table. The current status of the output and be queried and set via the *PinState* flag.

Offset	Name	Field	Bit	Description
0xF1000320	IO_OUTP_CTRL1	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..6]	-
		Polarity	[7]	0: low active, 1: high active
		---	[8..10]	
		Output mode	[11..15]	Mode
		---	[16..30]	
		PinState	[31]	RD: Current state of pin WR: New state of pin
0xF1000324	IO_OUTP_CTRL2	Same as IO_OUTP_CTRL1		

Table 76: Output control configuration register

Output mode

ID	Mode	Default
0x00	Off	
0x01	Output state follows 'PinState' bit	
0x02	Integration enable	Output 1
0x03	Incremental decoder compare	
0x04	tbd (SPI internal DCLK)	
0x05	tbd (SPI external DCLK)	
0x06	FrameValid	
0x07	Busy	
0x08	Follow corresponding input (Inp1 → Out1, Inp2 → Out2, …)	Output 2
0x09..0x0F	reserved	
0x10..0x1F	reserved	

Table 77: Output ID

The "Polarity" setting refers to the input side of the inverting optical coupler output, "PinState 0" switches off the output transistor and produces high level over the resistor.

11.4.14 Delayed Integration enable

A delay time between initiating exposure on the sensor and the activation edge of the IntEna signal can be set using this register. The *on/off* flag activates/deactivates integration delay. The time can be set in µs in *DelayTime*.

ⓘ Please note that only one edge is delayed.

ⓘ If *IntEna_Out* is used to control an exposure, it is possible to have a variation in brightness or to precisely time a flash.

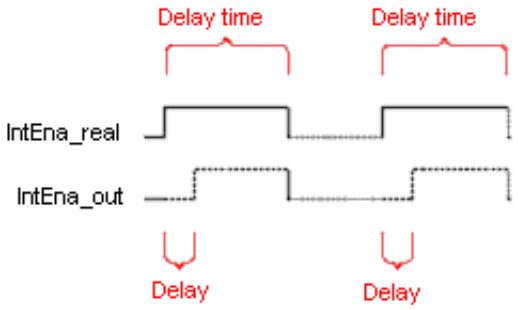


Figure 49: Delayed integration timing

Offset	Name	Field	Bit	Description
0xF1000340	IO_INTENA_DELAY	Presence_Inq	[0]	Indicates presence of this feature (read only)
		---	[1..5]	
		ON_OFF	[6]	Enable/Disable integration enable delay
		---	[7..11]	
		DELAY_TIME	[12..31]	Delay time in µs

Table 78: Delayed integration configuration register

11.4.15 GPDATA_BUFFER

GPDATA_BUFFER is a register that regulates the exchange of data between camera and host for programming the LUTs and the upload/download of the shading image.

GPDATA_INFO Buffer size query
GPDATA_BUFFER indicates the actual storage range

Offset	Name	Field	Bit	Description
0xF1000FFC	GPDATA_INFO	---	[0..15]	
		BufferSize	[16..31]	Size of GPDATA_BUFFER
0xF1001000	GPDATA_BUFFER			
…				
0xF10017FF				

Table 79: GPData buffer register

ⓘ GPDATA_BUFFER can be used by only one function at a time.

12 Firmware update

Firmware updates are possible without opening the camera.

You need:

- Programming cable E 1000666
- Software “Bootprog”
- PC or laptop with serial Interface (RS 232)
- Documentation for firmware update

Please contact your local dealer for further information.

13 Declarations of conformity

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Zertifiziert nach DIN ISO 9001
Zertifikat EN 1994 - 08

DECLARATION OF CONFORMITY

We Allied Vision Technologies GmbH

Taschenweg 2a, 07646 Stadtroda, Germany

declare under our sole responsibility that the product

Category Name	Digital black/white Camera (IEEE 1394)
Model Name:	Marlin F-033B

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 55022; EN 55024; EN 61000; FCC Class A

Following the provisions of 89/336/EEC directive(s) , amended by Directive 91/263 EEC, 92/31/EEC and 93/68/EEC

Stadtroda, November 20th, 2003

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declare under our sole responsibility that the product

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Model Name:	Marlin F-033C

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Model Name:	Marlin F-080B

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

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Zertifiziert nach DIN ISO 9001
Zertifikat EN 1994 - 08

DECLARATION OF CONFORMITY

We Allied Vision Technologies GmbH

Taschenweg 2a, 07646 Stadtroda, Germany

declare under our sole responsibility that the product

Category Name	Digital color Camera (IEEE 1394)
Model Name:	Marlin F-080C

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 55022; EN 55024; EN 61000; FCC Class A

Following the provisions of 89/336/EEC directive(s) , amended by Directive 91/263 EEC, 92/31/EEC and 93/68/EEC

Stadtroda, November 20th, 2003

Frank Grube
Managing Director

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DECLARATION OF CONFORMITY

We Allied Vision Technologies GmbH

Taschenweg 2a, 07646 Stadtroda, Germany

declare under our sole responsibility that the product

Category Name	Digital black/white Camera (IEEE 1394)
Model Name:	Marlin F-145B2

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 55022; EN 55024; EN 61000; FCC Class A

Following the provisions of 89/336/EEC directive(s) , amended by Directive 91/263 EEC, 92/31/EEC and 93/68/EEC

Stadtroda, November 20th, 2003

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DECLARATION OF CONFORMITY

We Allied Vision Technologies GmbH

Taschenweg 2a, 07646 Stadtroda, Germany

declare under our sole responsibility that the product

Category Name	Digital color Camera (IEEE 1394)
Model Name:	Marlin F-145C2

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 55022; EN 55024; EN 61000; FCC Class A

Following the provisions of 89/336/EEC directive(s) , amended by Directive 91/263 EEC, 92/31/EEC and 93/68/EEC

Stadtroda, November 20th, 2003

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DECLARATION OF CONFORMITY

We Allied Vision Technologies GmbH

Taschenweg 2a, 07646 Stadtroda, Germany

declare under our sole responsibility that the product

Category Name	Digital black/white Camera (IEEE 1394)
Model Name:	Marlin F-131B

to which this declaration relates is in conformity with the following standard(s) or other normative document(s)

EN 55022; EN 55024; EN 61000; FCC Class A

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Stadtroda, November 20th, 2003

Frank Grube
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